Washington State Department of Transportation

Memorandum

Jan. 22, 2019

TO: Roger Millar
Mail Stop 47316

THRU: Patty Rubstello

FROM: Edward Barry
206-464-1217

SUBJECT: SR 99 Investment Grade Traffic and Revenue Study

I am pleased to submit the State Route 99 Investment Grade Traffic and Revenue Study prepared by Stantec Consulting Services Inc., WSP USA Inc. and BERK Consulting.

The Legislature directed WSDOT to collect tolls in the SR 99 tunnel in order to fund ongoing tunnel maintenance and operations, and to generate $200 million to repay construction bonds.

WSDOT commissioned this independent traffic analysis to support both the Washington State Transportation Commission's (WSTC) toll rate-setting process for SR 99 tunnel and the sale of bonds to finance the $200 million capital investment required by state law.

The WSTC set toll rates in October 2018 of $1 to $2.25 with *Good To Go!* pass. This report demonstrates the toll rates can meet the state's obligations to repay construction bonds and fund the safe operation of the tunnel.

Prior to and throughout the toll rate-setting process, WSDOT and WSTC met with partner agencies – the City of Seattle, the Port of Seattle, and King County – to ensure local government perspectives, priorities and insights were an integral part of considerations in the development of this report. We will continue to work closely with them as the process to implement tolls moves forward.

If you have questions or comments about this report, please call me directly.

EG
Attachment: SR 99 Investment Grade Traffic and Revenue Study

cc: Alaskan Way Viaduct Replacement Program
WSDOT Headquarters Budget Office

SR 99 Investment Grade Traffic and Revenue Study

Revised September 15, 2017
Revised December 7. 2018

Prepared for:
WSDOT Toll Division

Prepared by:
Stantec Consulting Services Inc.

and

WSP USA Inc.
BERK Consulting

March 3, 2017

Revision	Description	Author		Quality Check		Independent Review	

Sign-off Sheet

This document entitled SR 99 Investment Grade Traffic and Revenue Study was prepared by Stantec Consulting Services Inc. ("Stantec") for the account of WSDOT (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ______________________
(signature)

Reviewed by ______________________
(signature)

Approved by ______________________
(signature)

Table of Contents

LIST OF TABLES

LIST OF FIGURES

Glossary

T&R – Traffic and Revenue

WSDOT – Washington State Department of Transportation

AWV – Alaskan Way Viaduct

DTA – Dynamic Traffic Assignment

PSRC – Puget Sound Regional Council

Project – SR 99 Tolled Tunnel Project

GP Lane – General Purpose Lane

HOV – High Occupancy Vehicle

CAGR – Compound Annual Growth Rate

CBD – Central Business District

1.0 INTRODUCTION

The Alaskan Way Viaduct, an elevated section of State Route 99 in Seattle, was built in the 1950s, and decades of daily wear and tear have taken their toll on the structure. Because of the viaduct's age and vulnerability to earthquakes, replacing it is critical to public safety.

The Alaskan Way Viaduct Replacement Program includes projects led by the Washington State Department of Transportation, King County, the City of Seattle and the Port of Seattle. The Federal Highway Administration is a partner in this effort.

Major elements of the program include:

- A two-mile-long tunnel beneath downtown Seattle.
- A mile-long stretch of new highway that connects to the south entrance of the tunnel, near Seattle's stadiums.
- A new overpass at the south end of downtown that allows traffic to bypass train blockages near Seattle's busiest port terminal.
- Demolition of the viaduct's downtown waterfront section.
- A new Alaskan Way surface street along the waterfront that connects SR 99 to downtown.

This report is focused on the traffic and revenue potential for the proposed SR 99 Tolled Tunnel Project.

1.1 STUDY PURPOSE

The Washington State Department of Transportation (WSDOT) needs traffic and toll revenue (T&R) estimation support for the replacement Alaskan Way Viaduct (SR 99) tolled tunnel project. The SR 99 Alaskan Way Viaduct, built in the 1950s, carries approximately 110,000 cars daily along Seattle's waterfront. The viaduct was already showing signs of age and deterioration when it was further weakened during the 2001 Nisqually earthquake.

In 2009, the Washington State Legislature passed ESSB 5768 authorizing the WSDOT to pursue the replacement tunnel project. This bill outlined the project's funding and directed WSDOT to pursue toll revenue as part of the budget. A final environmental impact statement was completed in 2011 followed by Federal Highway Administration's issuance of a Record of Decision approving the tolled tunnel. As part of the replacement project, the new SR 99 corridor will need traffic and toll revenue estimates for developing toll policies and evaluating toll scenarios and investment grade traffic and revenue estimates for financing. In addition, the Washington State Transportation Commission will utilize the outputs from this study for traffic and revenue estimation support.

The purpose of this study is to evaluate toll options and provide long range T&R forecasts for the proposed SR 99 Tolled Tunnel Project. Our efforts included traffic data collection, the development and calibration of forecasting models, and independent socioeconomic forecasts.

1.2 CONSULTANT TEAM

Stantec led the team for the T&R Study and was responsible for project management, coordination, data collection, calibration and validation of the T&R forecasting models, and forecasting traffic and gross toll revenues for the SR 99 Tolled Tunnel Project.

Several firms assisted in the preparation of the forecasts. They are:

- BERK Consulting (BERK) provided the socioeconomic and land use review and employment, population, and household projections used in the traffic model.
- WSP USA Inc. (WSP) performed gross potential revenue to net revenue calculations and estimations.
- Fehr & Peers (F&P) oversaw the data collection efforts, summarized existing conditions data, and assisted with modeling efforts.
- Ch2M Hill (CH2M) assisted with modeling efforts, primarily assisting with the Dynameq Dynamic Traffic Assignment (DTA) model.
- All Traffic Data (ATD) collected volume and classification data and performed travel time runs.
- Streetlight Data, Inc. provided origin-destination data for use in the travel demand and DTA models.

1.3 ORGANIZATION OF THE REPORT

The remainder of this report is organized in the following chapters:

Chapter 2 – Project Description and Setting. This chapter describes the SR 99 Tolled Tunnel Project configuration and purpose in the highway network. Also discussed are the other major roadways and transit options in the regional transportation network.

Chapter 3 – Existing Conditions. This chapter summarizes the traffic data collected throughout the study area including traffic volumes, travel speeds, and origin-destination patterns.

Chapter 4 – Socioeconomic Variables and Land Use. This chapter describes the historical trends as well as the socioeconomic projections used to develop the traffic forecasts, and the assessment of the region's economy and future developments in the study area.

Chapter 5 – Model Development and Calibration. This chapter explains the modeling methodology used to produce T&R forecasts. This includes a discussion of the regional travel demand model and the Dynameq DTA model.

Chapter 6 – Traffic and Revenue Forecasts. This chapter presents the long-range forecasts of traffic and toll revenue for the SR 99 as well as the assumptions and methodology used in preparing the forecasts. This section also compares the resulting forecasts of various tolling options.

Chapter 7 – Net Revenue Forecast. This chapter provides forecast analysis and assumptions of revenue adjustments and costs to derive annual net revenue projections for various tolling options.

Chapter 8 – Sensitivity Analyses. This chapter discusses the potential impact on the project's traffic and gross toll revenue potential under various input assumptions.

Chapter 8 – Risk Analysis. This chapter analyzes the probability distribution for simultaneously varying multiples inputs to the traffic and gross toll revenue potential for the project.

2.0 PROJECT DESCRIPTION AND SETTING

The SR 99 Tolled Tunnel Project is part of the overall program to build a new State Route 99 through Seattle and activate the Seattle waterfront. This program includes the SR 99 Tolled Tunnel, a mile-long stretch of new highway that connects to the south entrance of the tunnel, a new overpass at the south end of downtown to allow traffic to bypass train blockages near the port terminal, and a new Alaskan Way surface street along the waterfront that connects SR 99 to downtown. **Figure 2-1** highlights the overall Alaskan Way Viaduct Replacement Program.

This chapter discusses the existing highway and local street network and proposed key improvements in the study area for the SR 99 Tolled Tunnel Project.

2.1 SR 99 TOLLED TUNNEL

The SR 99 tunnel and associated AWV Program improvements will result in changes in travel patterns for SR 99 through and into downtown Seattle. The SR 99 tunnel will have full interchanges at the tunnel portals north and south of downtown near Republican Street and South King Street, respectively. Access for downtown traffic to and from the south would be provided from northbound SR 99 to Alaskan Way South and from Alaskan Way South to southbound SR 99 south of South King Street via new ramps. Traffic utilizing these ramps will be able to distribute to and from Alaskan Way via the downtown street grid using a number of cross streets instead of the single-point locations in downtown where the Columbia and Seneca Street ramps begin and end today. In the north portal area, access to and from SR 99 would be provided at Harrison and Republican Streets. Because the SR 99 tunnel would extend north of Harrison Street, SR 99 would no longer be a barrier to the connection of John, Thomas, and Harrison Streets, allowing the local street grid between Denny Way and Harrison Street to be connected. This will provide more route choices near the north portal for travel between and within South Lake Union, Belltown, and Downtown.

For trips traveling through downtown using SR 99, the decision points of whether to travel in the SR 99 tunnel or to divert via surface streets could occur at a number of places before or at the two tunnel portals and could in part depend on the congestion at these interchanges. For a northbound trip, if there are congested conditions exiting SR 99 to Alaskan Way South, it could influence the driver to travel through the SR 99 tunnel instead of diverting via surface streets or I-5 when the tunnel is tolled. A southbound trip would make this decision prior the southbound off-ramp to Aurora Avenue at the north portal.

2.2 SURFACE ALASKAN WAY

Part of the Alaskan Way Viaduct Replacement Program involves the construction of an enhanced surface Alaskan Way. This new Alaskan Way will traverse the west side of Seattle along the waterfront, connecting SR 99 to the downtown area. The proposed surface Alaskan Way will be two lanes in each direction and will create pedestrian- and vehicle-friendly access points to the waterfront.

Given the increased capacity on this link, it is expected that some of the trips that currently utilize the existing SR 99 will divert to the surface Alaskan Way once the SR 99 tunnel is completed and tolled since access to the SR 99 corridor will be re-configured with the proposed tunnel.

Figure 2-1: Alaskan Way Viaduct Replacement Program

2.3 PUBLIC TRANSPORTATION IN THE AREA

The Seattle Central Business District (CBD) contains numerous public transportation alternatives to driving a personal vehicle.

2.3.1 Central Link

Central Link is a light rail line running between the cities of Seattle and SeaTac. It is one of the lines in Sound Transit's Link Light Rail system. Service operates seven days a week, from 5 am to 1 am Monday through Saturday and from 6 am to midnight on Sundays. The northern terminus is at the University of Washington, next to Husky Stadium, where construction on a northern extension is in progress. From there, it travels through a tunnel to Capitol Hill Station on Broadway. The tunnel then transitions into the Downtown Seattle Transit Tunnel at Westlake Station.

2.3.2 Sounder Commuter Rail

Sounder commuter rail is a regional rail service operated by BNSF on behalf of Sound Transit. Service operates Monday through Friday during peak hours from Seattle north to Everett and south to Lakewood. As of 2015, schedules serve the traditional peak commutes, with most trains running inbound to Seattle in the morning and outbound from Seattle in the afternoon. The Sounder commuter rail consists of a South Line and a North Line. The South Line essentially connects Seattle with Tacoma and the North Line connects Seattle with Everett.

2.3.3 Sound Transit Express Buss

Sound Transit Express Bus is a network of regional express buses, operated by the multi-county transit agency, Sound Transit. The routes connect major regional hubs throughout 53 cities in three counties (King, Pierce, and Snohomish) in the Puget Sound region. Unlike a typical transit bus, Sound Transit Express Bus routes typically make limited stops as they travel longer distances on the freeways. Most routes operate seven days a week, with service throughout the day. Where available, buses use transit-only lanes, high-occupancy vehicle lanes, high-occupancy toll lanes, express lanes, and direct access ramps to speed travel times.

2.3.4 King County Metro

King County Metro (“Metro”), officially the King County Department of Transportation Metro Transit Division, is the public transit authority of King County, Washington. Metro is the eighth-largest transit bus agency in the United States. Metro combines service patterns typical of both city and suburban bus networks. The city network, was descended in large part from the Seattle Transit system of converted streetcar routes. Most service is operated in a hub-and-spoke pattern centered either on downtown Seattle or the University of Washington, with lesser amounts of crosstown service. The suburban network typically operates on major streets between the region’s employment and population centers.

Table 2-1 provides a system-wide summary of 2015 boardings and **Table 2-2** provides the AM and PM peak boardings for King County and Sound Transit Express Bus routes.

Table 2-1: System-wide Summary of 2015 Transit Boardings

Transit Routes	Type	Observed Daily Boarding
Central Link	Light Rail	30,553
Tacoma Link	Rail	3,966
Sounder North	Rail	14,063
Sounder South	Rail	
Sound Transit Express	Bus	62,237
King County Metro	Bus	403,660
Total		514,479

Table 2-2: Summary of Transit Boardings for Selected King County/Sound Transit Express Bus Lines

Time Period	Total # of Routes	Observed Boarding
AM	208	109,929
MD	144	134,316

3.0 EXISTING CONDITIONS

A key component in developing an investment grade T&R forecast is the creation of a base year database to inform the traffic and tolling analysis. The following provides an overview of the data collection program for the Alaskan Way Viaduct (SR 99) Investment Grade Traffic and Revenue Study. The collected travel data was used to provide an overview of traffic patterns and conditions over time, support validation of the regional transportation and Dynamic Traffic Assignment (DTA) models, and quantify corridor specific speeds and travel times.

The data collection program included the following data sets:

- Automated Traffic Recorders (ATRs)
- Turning Movement Counts (TMCs)
- Vehicle Classification Counts
- Origin-Destination Data
- Travel Time / Speed Surveys

Based on the scope of the T&R Study, the extents of the DTA model were examined to determine the appropriate study area to accurately estimate diversion from the SR 99 tolled tunnel. The data collection program outlined in the following sections focuses on detailed traffic information in the downtown Seattle area along the project corridor and near the entry and exit termini of the proposed tunnel. **Figure 3-1** below shows the extents of the DTA model. The count program was designed to ensure calibration and validation of the DTA model would be sufficient to produce investment grade quality traffic and revenue forecasts.

The following sections describe the approach to obtain the key data sets, reasons for including the data, and discussion on how the data was utilized in the calibration and validation of forecasting models.

3.1 DATA COLLECTION PROGRAM

Traffic data in the Project corridor and study area were collected over a multi-week period in late February and early March 2015. The data collected included traffic volumes, speeds, travel times, and origin-destination patterns. The focus of the data collection program was to record typical weekday traffic along SR 99 as well as critical parallel and feeder routes. In addition to data collected in the field, historical traffic information was collected from regular counts conducted by the Seattle Department of Transportation (SDOT) and permanent count stations in the freeway system maintained by WSDOT. Historical speed information was downloaded from the SigAlert website and supplemented with INRIX data. Origin-destination data was obtained from Streelight Data.

3.1.1 Publicly Available Data

The consultant team obtained ATR data from the City of Seattle and the WSDOT. Both Seattle and WSDOT have historical traffic count data for the study area. **Figure 3-2** below details the locations where count data were collected in 2014. Similar information exists for 2012 and 2013. The City of Seattle publishes peak hour (AM and PM) and daily volumes at each of these locations; however, more detailed count data were requested at 39 locations throughout the study area. In addition, turning movement counts collected in 2014 as part of the SDOT Center City Connector Streetcar project were provided.

Figure 3-1: Extents of Dynamic Traffic Assignment (DTA) Model

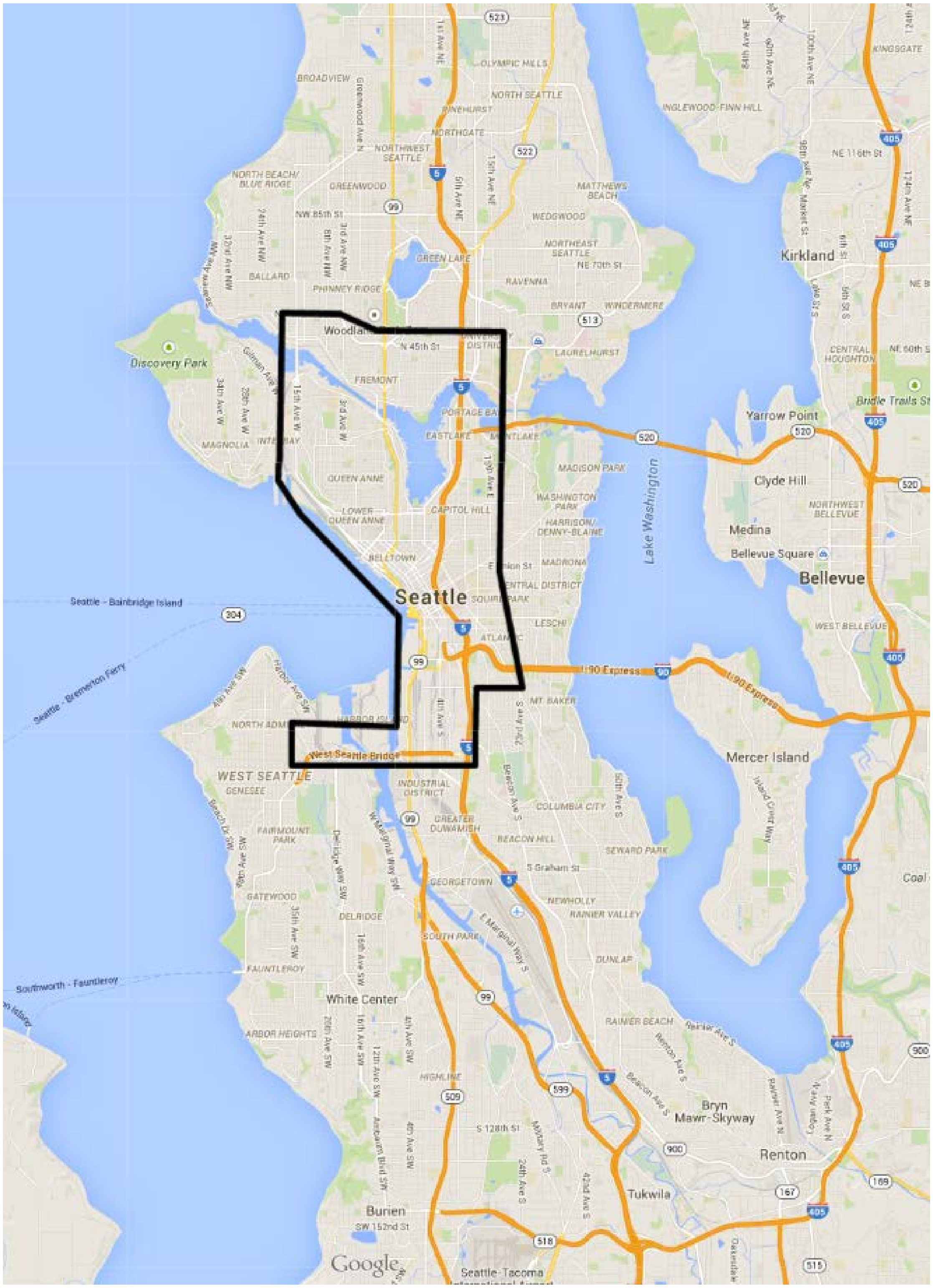
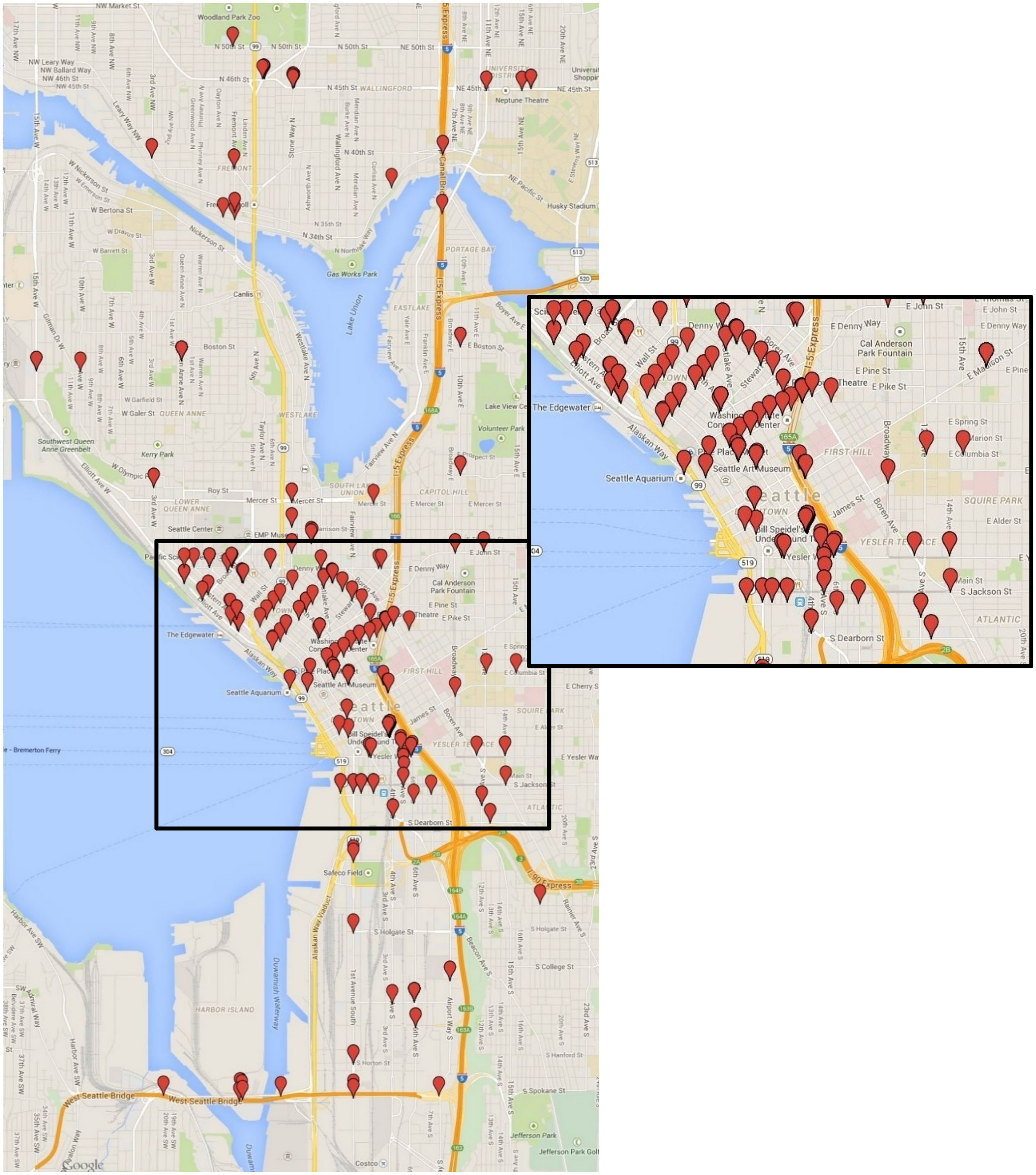


Figure 3-2: City of Seattle Count Locations (2014)

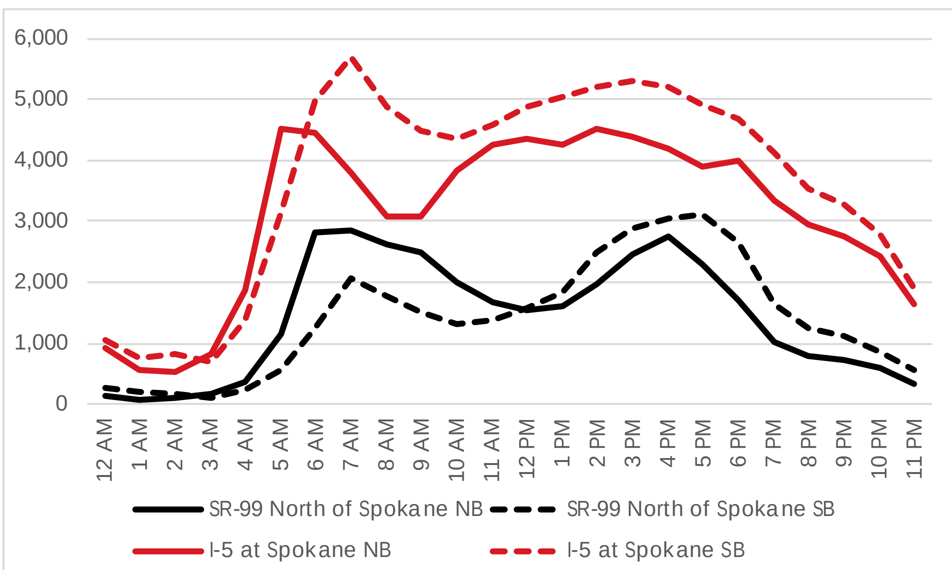


3.1.2 Automated Traffic Recorders (ATRs)

To assist in model calibration, Automated Traffic Recorder (ATR) traffic counts were collected at 95 locations throughout the study area. Most of the arterial data were collected for seven days using tube counters. In a few locations, video cameras were used to further validate the counts. Data for SR 99 and the freeways within the study area were collected by WSDOT. From the data, AM, Midday, PM, and Evening peak hour volume and daily traffic profiles were summarized for each location.

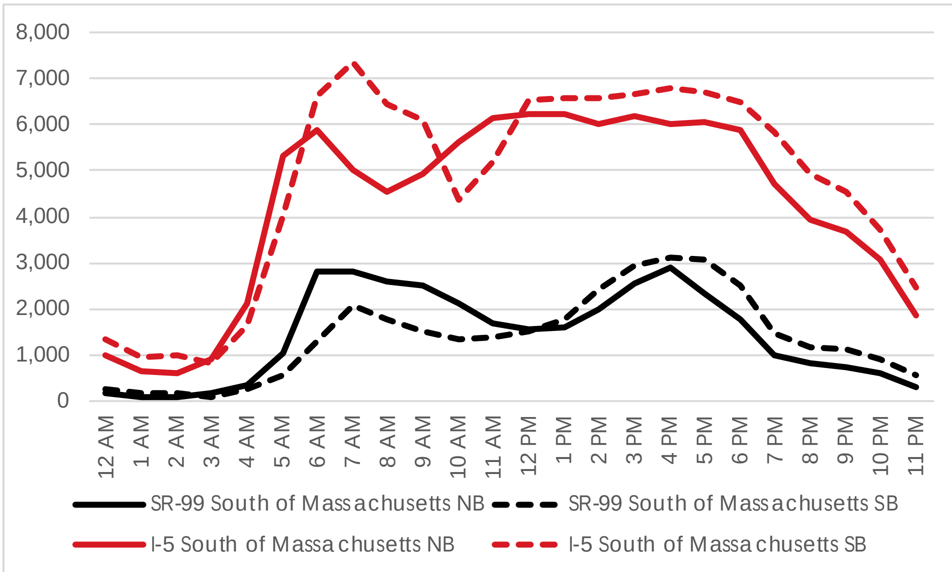
SR 99 shows distinct AM and PM peak hours in both directions north of Spokane Street, with a maximum hourly volume of about 3,000 vehicles. Northbound traffic peaks in the AM and southbound peaks in the PM. I-5 experiences more congestion during the AM peak hour. In the northbound direction, hourly volume reaches capacity near 4,500 vehicles at 5am north of Spokane Street. Demand exceeds capacity and congestion begins at 7am, which can be seen by the drastic volume decrease shown in **Figure 3-3** during the peak period when volumes would normally be expected to be increasing. Northbound volume remains steady at 3,000 vehicles during the 8am to 9am rush hour. Unmet demand is realized and congestion subsides around 10am, where the roadway remains at free-flow capacity of approximately 4,500 vehicles per hour throughout the day. Southbound I-5 reaches 5,500 vehicle capacity at 7am, where volumes then decrease as congestion begins between 7am and 8am.

Figure 3-3: Average Weekday Hourly Volume North of S. Spokane Street



Hourly volume on SR 99 south of South Massachusetts Street follows the same trend as noted above: distinct peaks with a throughput capacity of approximately 3,000 vehicles. I-5 trends also mimic those noted above but with a higher capacity due to the lane addition from the Spokane Street Viaduct. Northbound I-5 demand peaks at 6,000 vehicles per hour and southbound demand peaks at 7,000 vehicles. There is a large decrease in flow in the southbound direction at 10am where volume drops to 4,200 vehicles as shown in **Figure 3-4**.

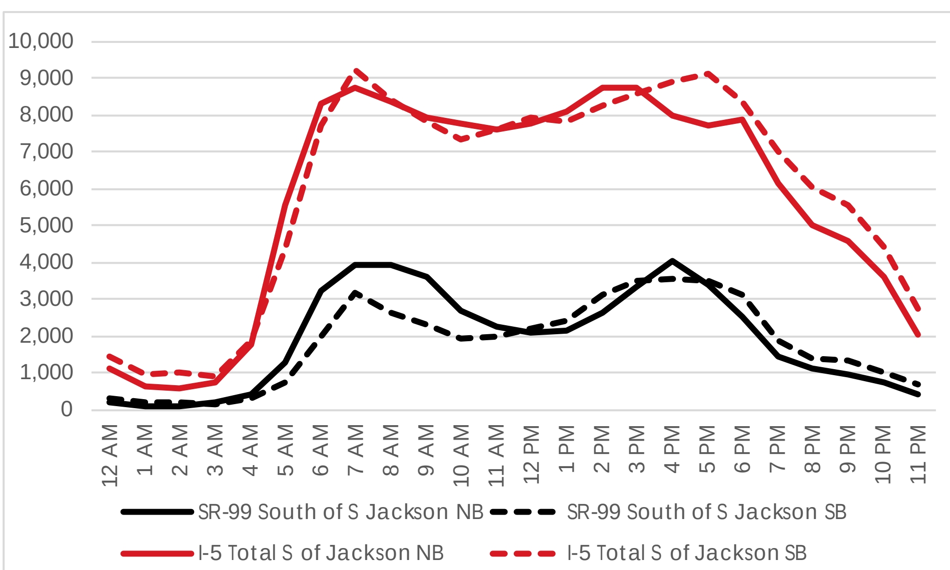
Figure 3-4: Average Weekday Hourly Volume South of S. Massachusetts Street



Directional peaks on SR 99 south of South Jackson Street are almost equal in both directions. The northbound AM peak lasts between 2 to 3 hours; the southbound AM peak is sharp and lasts for one hour only. The opposite is true in the PM peak hour as shown in **Figure 3-5**. The SR 99 roadway has a higher capacity in this area at 4,000 vehicles per hour.

I-5 shows a symmetrical trend in the area south of South Jackson Street. Capacity reaches close to 9,000 vehicles in both directions. The northbound direction may experience congestion between 4pm and 6pm, as can be seen in the dip in throughput volume between those hours.

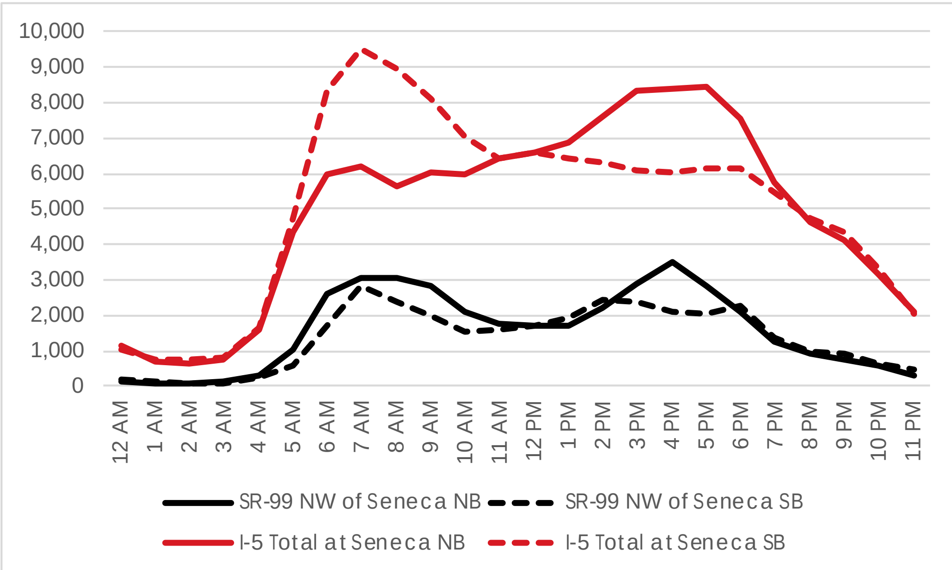
Figure 3-5: Average Weekday Hourly Volume South of S. Jackson Street



SR 99 north of Seneca Street presents the same long northbound AM peak hour and short southbound AM peak hour as the location described above, although the southbound direction

may experience some congestion. There is a slight drop in throughput during the PM peak hour. The trends on I-5 display minimal congestion north of Seneca Street. Approximately 3,000 northbound AM peak hour vehicles exit I-5 between Jackson Street and Seneca Street – destined for Seattle's Central Business District. The express lanes operate in the southbound direction in the AM and in the northbound direction in the PM, as can be seen by the hourly traffic profiles in **Figure 3-6**.

Figure 3-6: Average Weekday Hourly Volume North of Seneca Street



3.1.3 Turning Movement Counts (TMCs)

Turning movement counts (TMCs) are required to validate the DTA model. The consultant team collected TMC data from various sources. Historical (2009 – 2011) turning movement counts are available from work performed for the Alaskan Way Viaduct Seawall Replacement Study (Synchro data) and recently (2014) the SDOT Center City Connector Streetcar project.

After reviewing the available TMC data, the consultant team developed a list of new intersection locations within the study area that required current year traffic counts. Some counts overlapped with the historic counts to develop adjustment factors so that older counts can be scaled to 2015 conditions. TMCs were completed mid-week (Tuesday, Wednesday, or Thursday) for the AM peak period (7-10am), the MD peak period (12-2pm), and the PM peak period (4-7pm) to help with calibration and validation of the DTA model. Data was summarized into 15-min increments and incorporated into the DTA model as volume targets.

Figure 3-7, **Figure 3-8**, and **Figure 3-9** provide maps of ATR and TMC locations.

Figure 3-7: Count Locations (Northern End of Study Area)

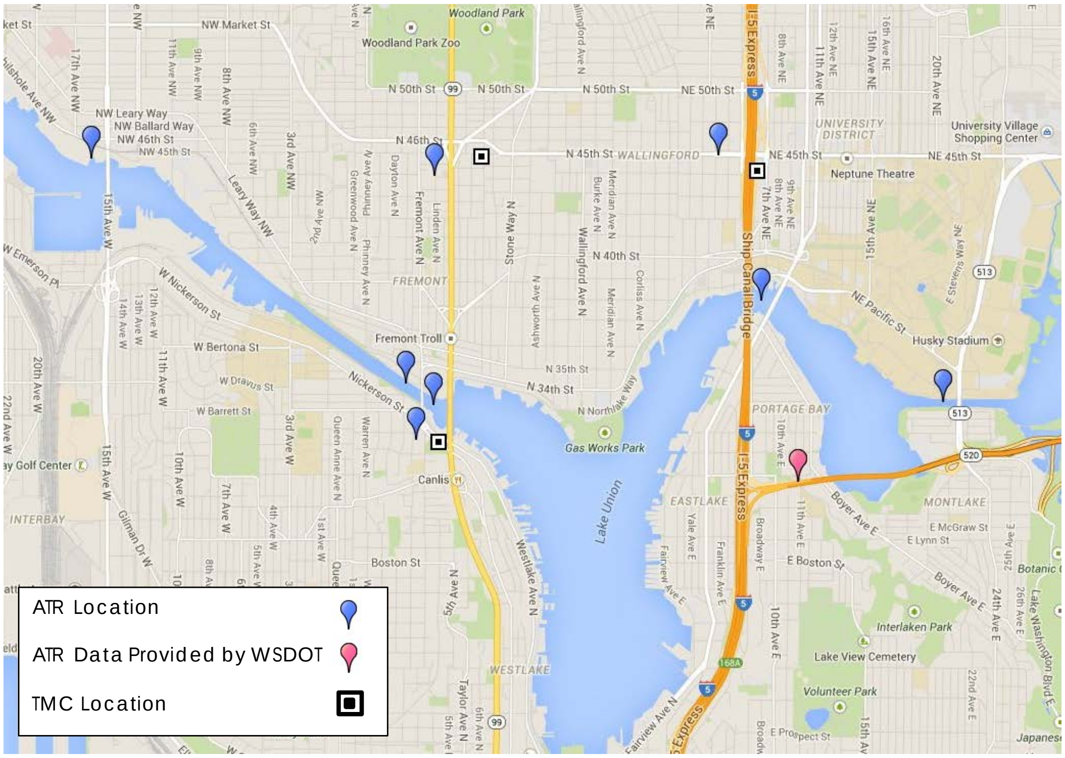


Figure 3-8: Count Locations (Middle of Study Area)

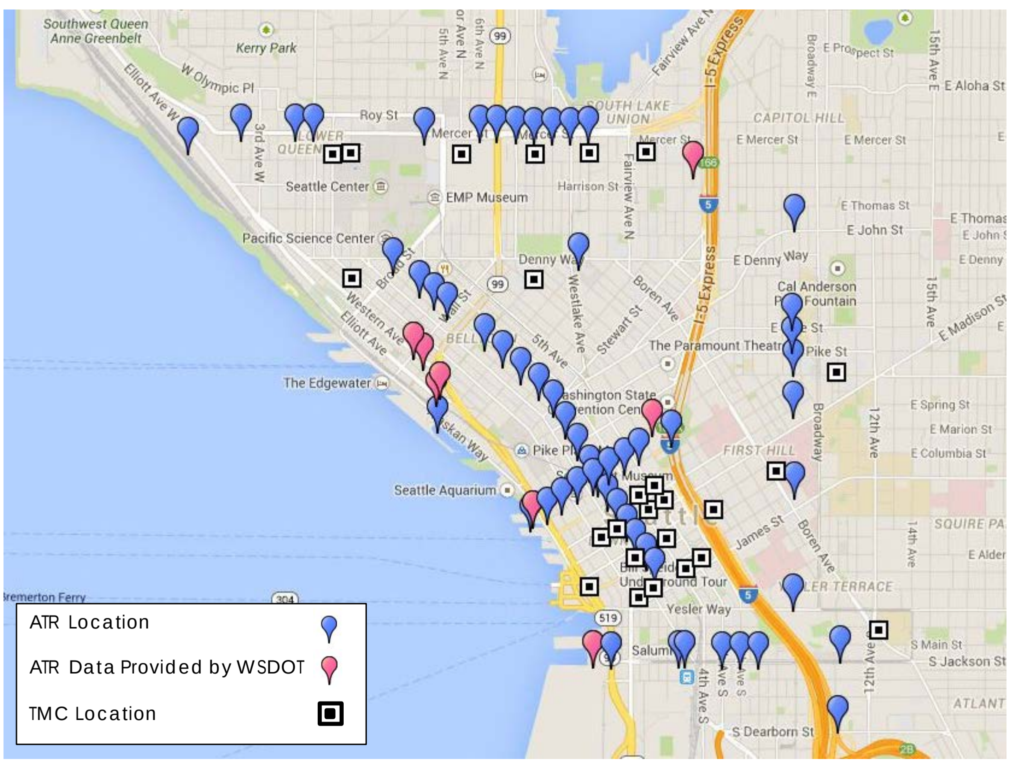
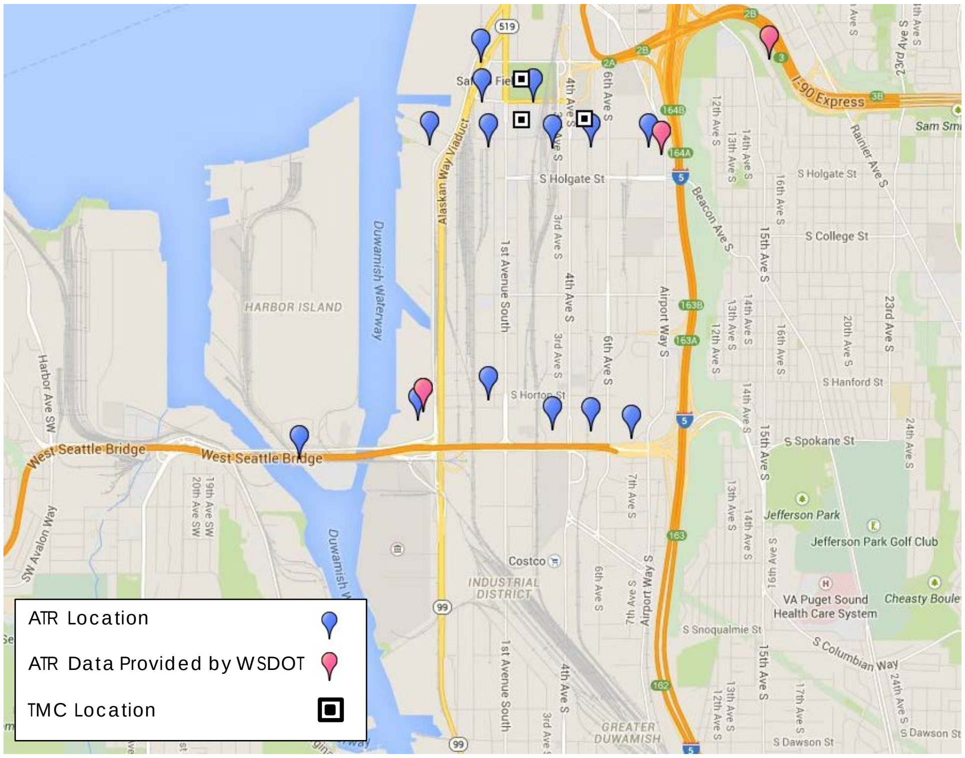


Figure 3-9: Count Locations (Southern End of Study Area)



3.1.4 Vehicle Classification Counts

It is important to quantify the level of commercial vehicles traveling through the CBD as truck trips are expected to comprise a portion of SR 99 tunnel traffic. Currently, 1st Avenue south of Massachusetts Street is a major truck route in and out of Seattle and has the highest percentage of heavy vehicles. There were 27 and 21 percent heavy vehicles on this section of 1st Avenue in the northbound and southbound directions, some of which may have diverted from the SR-99 pending weight restrictions on the existing Viaduct. **Table 3-1**, **Table 3-2**, and **Table 3-3** provide classification count data by direction and heavy vehicle percentage by roadway.

Table 3-1: Average Weekday Vehicle Classification Counts (Northbound)

Location	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4+ Axle Trucks
1st Ave N s/o Mercer St	120	5,816	543	210	197	28	163
1st Ave n/o Seneca St	219	6,635	2,720	221	437	123	539
4th Ave n/o Seneca St	375	9,129	1,302	342	355	201	455
1st Ave S s/o S Massachusetts St	122	2,147	6,407	241	2,567	85	300
4th Ave S s/o S. Massachusetts St	209	9,811	3,108	325	1,103	222	647
1st Ave S n/o S. Spokane St	142	6,913	1,268	162	478	107	537
4th Ave S n/o S. Spokane St	178	9,782	640	52	214	199	385

Table 3-2: Average Weekday Vehicle Classification Counts (Southbound)

Location	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4+ Axle Trucks
1st Ave n/o Seneca St	107	4,367	444	96	144	34	48
2nd Ave n/o Seneca St	173	4,218	2,667	284	461	128	504
1st Ave S s/o S Massachusetts St	226	1,865	6,433	223	1,504	170	385
4th Ave S s/o S. Massachusetts St	414	8,151	1,281	179	497	279	372
1st Ave S n/o S. Spokane St	216	4,498	1,312	86	533	75	107
4th Ave S n/o S. Spokane St	134	6,925	1,017	93	368	185	317

Table 3-3: Average Weekday Heavy Vehicle Percentages by Roadway

Location	NB	SB
1st Ave n/o Seneca St	12%	6%
2nd Ave n/o Seneca St	-	16%
4th Ave n/o Seneca St	11%	-
1st Ave S s/o S Massachusetts St	27%	21%
4th Ave S s/o S. Massachusetts St	15%	12%
1st Ave S n/o S. Spokane St	13%	12%
4th Ave S n/o S. Spokane St	7%	11%

3.1.5 Origin-Destination (O-D) Data

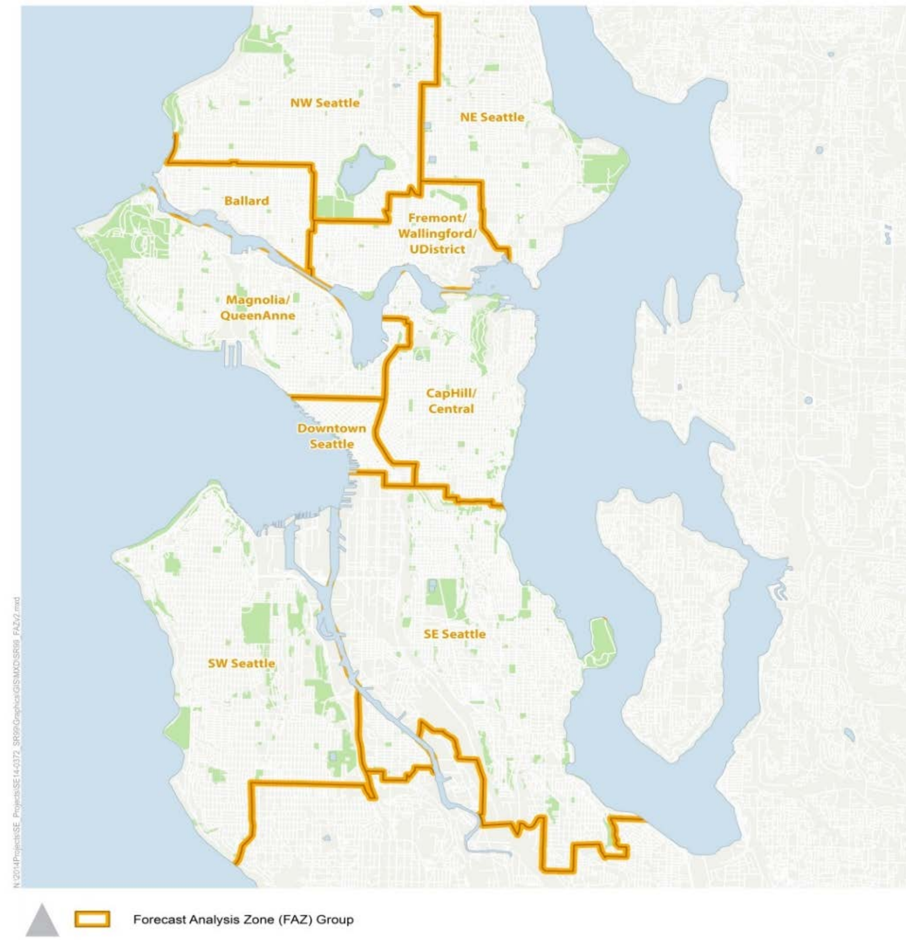
An important part of the data collection program was obtaining observed flows within and through the study area. The following four unique data sets were examined.

- American Community Survey (ACS): Five-year average of work trips by mode (2006–10)
- Puget Sound Regional Council (PSRC): 2014 regional household survey
- AirSage: smart phone GPS data to track person trip patterns
- Streetlight: Zone to zone (ramp to ramp) vehicle trip patterns

3.1.5.1 American Community Survey

The American Community Survey (ACS) provides an estimate of a five-year average for journey to work data. The data also provides information on the mode of travel to and from a zone. For the purposes of this study, the data were aggregated to 12 districts. **Figure 3-10** shows the analysis districts within the City of Seattle. This district scheme is also used to show the travel patterns obtained for the PSRC 2014 Household Survey and the AirSage data.

Figure 3-10: ACS Analysis Districts



Given the location of the proposed SR 99 tunnel, it is important to examine trip pairs as potential users of SR 99. For example, trips that originate in SE or SW Seattle destined for a zone to the north would be potential trips for the SR 99. **Table 3-4** summarizes work trips from a particular origin zone. Trips highlighted in light blue are potential users of the SR 99 tunnel. As an example, 68 percent of work trips that originate in SE Seattle are destined for a zone where a potential northbound trip in the SR 99 tunnel is possible. Conversely, 36 percent of trips that originate in Ballard are destined for a zone where a potential southbound trip in the SR 99 tunnel is possible. It is important to note that a lot of trips begin and end in the same zone.

Table 3-5 summarizes the same information based on destination zone.

Table 3-6 provides the modal shares for the ACS data based on zone of origin. Drive alone and carpool (essentially passenger vehicles) represent around 50 percent of the mode choice in the area, though these percentages decrease rapidly as you approach the Seattle CBD. For trips that originate in the Seattle CBD, less than 10 percent are vehicle trips.

Table 3-4: ACS Percent of Work Trips from a Residence (By Origin)

	NW Seattle	NE Seattle	Ballard	Magnolia / Queen Anne	Capitol Hill / Central District	Seattle CBD	SE Seattle	SW Seattle	Total
NW Seattle	23%	23%	7%	12%	7%	18%	8%	2%	100%
NE Seattle	6%	48%	3%	9%	8%	18%	6%	1%	100%
Ballard	4%	20%	18%	13%	8%	24%	11%	1%	100%
Magnolia / Queen Anne	3%	13%	4%	33%	8%	30%	7%	1%	100%
Capitol Hill / Central Dist	3%	14%	1%	10%	33%	29%	9%	1%	100%
Seattle CBD	2%	10%	4%	10%	7%	56%	9%	1%	100%
SE Seattle	4%	13%	3%	9%	15%	24%	30%	2%	100%
SW Seattle	3%	11%	2%	10%	9%	24%	16%	26%	100%

Table 3-5: ACS Percent of Work Trips to a Work Place (By Destination)

	NW Seattle	NE Seattle	Ballard	Magnolia / Queen Anne	Capitol Hill / Central District	Seattle CBD	SE Seattle	SW Seattle
NW Seattle	48%	12%	23%	13%	8%	10%	9%	5%
NE Seattle	26%	56%	20%	20%	19%	22%	17%	9%
Ballard	3%	4%	24%	6%	3%	5%	5%	2%
Magnolia / Queen Anne	5%	6%	11%	29%	7%	13%	7%	3%
Capitol Hill / Central Dist	6%	9%	4%	12%	38%	18%	11%	4%
Seattle CBD	1%	1%	3%	3%	2%	8%	3%	1%
SE Seattle	6%	6%	9%	8%	14%	11%	30%	5%
SW Seattle	5%	5%	5%	10%	9%	12%	17%	71%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 3-6: ACS Work Trip Mode Shares to the Seattle CBD

	Drove Alone	Carpool	Public Transit	Walk or Bike	Other	Work from Home	Total
NW Seattle	42%	12%	43%	3%	0%	0%	100%
NE Seattle	37%	10%	48%	4%	1%	0%	100%
Ballard	25%	13%	54%	6%	2%	0%	100%
Magnolia/ Queen Anne	35%	7%	46%	11%	2%	0%	100%
Capitol Hill/ Central Dist	23%	6%	37%	33%	1%	0%	100%
Seattle CBD	8%	1%	11%	63%	3%	15%	100%
SE Seattle	40%	15%	41%	4%	1%	0%	100%
SW Seattle	39%	15%	43%	2%	1%	0%	100%

3.1.5.2 PSRC

The PSRC 2014 Household Travel Study (release 2) was obtained to extract work and non-work travel patterns for the study area. The travel data is summarized in **Table 3-7** and **Table 3-8**. PSRC data are summarized by zip code which created some inconsistencies between the Analysis Districts used for the ACS Journey to Work data. Comparisons between the two data sources, however, were created where possible to ensure that the ACS and PSRC Household Travel Survey provided a consistent view of origin-destination patterns in the region.

Table 3-7: PSRC Percent of Work Trips from a Residence (By Origin)

	NW Seattle	NE Seattle	Ballard	Magnolia / Queen Anne	Capitol Hill / Central District	Seattle CBD	SE Seattle	SW Seattle	Total
NW Seattle	10%	40%	0%	9%	4%	35%	2%	0%	100%
NE Seattle	1%	30%	3%	16%	13%	30%	6%	1%	100%
Ballard	3%	14%	13%	23%	3%	39%	4%	0%	100%
Magnolia / Queen Anne	3%	11%	2%	25%	5%	38%	14%	3%	100%
Capitol Hill / Central Dist	1%	17%	1%	14%	17%	45%	6%	0%	100%
Seattle CBD	0%	11%	1%	12%	4%	61%	13%	0%	100%
SE Seattle	0%	20%	2%	8%	11%	41%	18%	0%	100%
SW Seattle	0%	13%	0%	12%	6%	35%	24%	10%	100%

Table 3-8: PSRC Percent of Work Trips to a Work Place (By Destination)

	NW Seattle	NE Seattle	Ballard	Magnolia / Queen Anne	Capitol Hill / Central District	Seattle CBD	SE Seattle	SW Seattle
NW Seattle	59%	22%	0%	8%	5%	12%	3%	0%
NE Seattle	14%	43%	47%	34%	44%	26%	19%	16%
Ballard	5%	3%	28%	6%	1%	4%	2%	0%
Magnolia / Queen Anne	18%	6%	11%	21%	6%	13%	17%	17%
Capitol Hill / Central Dist	4%	9%	4%	12%	22%	15%	7%	2%
Seattle CBD	0%	2%	2%	3%	2%	7%	5%	0%
SE Seattle	0%	9%	8%	5%	12%	12%	18%	0%
SW Seattle	0%	7%	0%	10%	8%	12%	29%	66%
Total	100%	100%	100%	100%	100%	100%	100%	100%

3.1.5.3 Airsage

One last dataset was compiled regarding regional origin-destination patterns. For this study the consultant team utilized a unique new dataset—mobile device location tracking. Mobile devices (phones, tablets, and other internet connected devices) provide a means to directly observe personal travel patterns, which can be used to supplement a travel model's forecast. For this study, data from AirSage, a mobile location data processing firm, were summarized. This AirSage data were collected in the spring of 2012 and covers the study area.

AirSage takes raw mobile device location data, and anonymously aggregates the data to protect a user's privacy. The AirSage data was aggregated into general travel sheds within and around the study area. The level of accuracy for the AirSage data is roughly on the scale of the PSRC Forecast Analysis Zone (FAZ) system. The FAZ system can distinguish patterns at the neighborhood scale (e.g., from Capitol Hill to West Seattle). The AirSage data provides total travel flows for the AM and PM peak commute periods (6am to 10am and 3pm to 7pm) as well as daily travel patterns. **Table 3-9** shows the AM travel patterns for all trips in the AM peak period. **Table 3-10** contains travel patterns for AM work trips from a residence (by origin) and **Table 3-11** displays AM work travel patterns to a workplace (by destination).

Each of the three origin-destination datasets as reviewed and compared to origin-destination patterns inherent in the regional travel demand model. Chapter 5 of this report summarizes how origin-destination patterns in the regional travel demand model and DTA model were reviewed and adjusted.

Table 3-9: Airsage Percent of all AM Trips from a Residence (By Origin)

	NW Seattle	NE Seattle	Ballard	Fremont / U District	Magnolia / Queen Anne	Capitol Hill / Central District	Seattle CBD	SE Seattle	SW Seattle	Total
NW Seattle	34%	6%	6%	9%	12%	9%	15%	6%	2%	100%
NE Seattle	11%	37%	2%	13%	7%	11%	12%	6%	1%	100%
Ballard	15%	3%	23%	9%	16%	9%	16%	7%	2%	100%
Fremont/ U District	9%	6%	4%	30%	12%	13%	17%	6%	2%	100%
Magnolia/ Queen Anne	8%	3%	6%	7%	38%	9%	17%	9%	4%	100%
Capitol Hill/ Central Dist.	6%	4%	2%	10%	8%	39%	12%	14%	4%	100%
Seattle CBD	7%	3%	3%	6%	9%	7%	43%	15%	8%	100%
SE Seattle	4%	2%	1%	4%	6%	16%	14%	48%	6%	100%
SW Seattle	2%	1%	1%	3%	7%	9%	16%	14%	46%	100%

Table 3-10: Airsage Percent of all AM Work Trips from a Residence (By Origin)

	NW Seattle	NE Seattle	Ballard	Fremont / U District	Magnolia / Queen Anne	Capitol Hill / Central District	Seattle CBD	SE Seattle	SW Seattle	Total
NW Seattle	8%	6%	5%	12%	18%	14%	26%	9%	2%	100%
NESeattle	11%	8%	2%	20%	11%	17%	21%	8%	1%	100%
Ballard	11%	4%	0%	13%	18%	14%	29%	9%	2%	100%
Fremont/ U District	10%	6%	5%	2%	15%	16%	32%	10%	3%	100%
Magnolia / Queen Anne	11%	4%	6%	8%	13%	13%	27%	13%	4%	100%
Capitol Hill / Central Dist.	8%	6%	2%	15%	12%	11%	20%	20%	6%	100%
Seattle CBD	15%	6%	6%	12%	13%	7%	1%	27%	12%	100%
SE Seattle	5%	3%	1%	6%	10%	24%	25%	20%	7%	100%
SW Seattle	3%	1%	1%	5%	11%	15%	29%	21%	14%	100%

Table 3-11: Airsage Percent of all AM Work Trips to a Work Place (By Destination)

	NW Seattle	NE Seattle	Ballard	Fremont / U District	Magnolia / Queen Anne	Capitol Hill / Central District	Seattle CBD	SE Seattle	SW Seattle
NW Seattle	19%	24%	31%	23%	26%	16%	20%	12%	7%
NESeattle	18%	22%	10%	25%	11%	14%	11%	7%	3%
Ballard	8%	5%	0%	8%	8%	5%	7%	4%	2%
Fremont/ U District	8%	9%	10%	1%	8%	7%	9%	5%	4%
Magnolia / Queen Anne	16%	11%	23%	9%	11%	10%	12%	11%	9%
Capitol Hill / Central Dist.	10%	12%	7%	15%	9%	7%	8%	13%	11%
Seattle CBD	5%	3%	5%	3%	3%	1%	0%	5%	6%
SE Seattle	10%	10%	6%	9%	12%	24%	16%	22%	19%
SW Seattle	5%	5%	7%	7%	13%	15%	18%	22%	39%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

3.1.5.4 Streetlight Data

Understanding specific ramp-to-ramp movements through the downtown Seattle area was important, particularly given the access changes to the SR 99 corridor that will result as part of the tunnel construction. Streetlight Data provides a broad range of vehicle travel pattern data for select study locations, which can be both an area and a road segment. Travel patterns are identified in-device GPS data and can be joined with other data sources to estimate trip maker characteristics and trip purpose. For the SR 99 project, the consultant team used the Streetlight data to examine zone-to-zone (ramp-to-ramp) vehicle patterns on SR 99 and I-5 throughout the study area. The data was also used in validating both the regional travel model and the DTA model estimations within the study area, as detailed in Chapter 5 of this report.

Table 3-12 and **Table 3-13** summarize specific movements during the AM peak period by origin and destination, respectively.

Table 3-14 and **Table 3-15** summarize specific movements during the PM peak period by origin and destination, respectively.

Table 3-12: Streetlight AM O-D by Origin

ORIGIN ↓ / DESTINATION →	West Seattle Bridge WB	I-5 NB Express Lanes (N of SR 522)	S Atlantic Street Ramp	S. of Spokane St	W Seattle Br WB / SR99 SB off-ramp	I-90 Eastbound	NE 42nd Street Ramp	Edgar Martinez Drive	**Northbound I-5 CD to James**	Northbound I-5 CD to Madison Street	Mercer Street Westbound	NE 45th Street Ramp	NE 50th Street Ramp	Olive Way	**Seneca Street**	West Seattle Freeway WB	Columbia St/Cherry St (HOV only)	I-5 SB Mainline (S of Columbia)	Pike Street	Stewart Street / Eastlake Avenue	4th Avenue S	I-5 Northbound	NE 45th Street	NE 50th Street	S. of Spokane St.	6th Avenue S	Stewart Street	Union Street	John St	Western Avenue	1st Avenue S	**I-5 NB @ S. Forest**	W Seattle Br EB / SR99 NB on-ramp	John St.
1st Avenue S	100%																																	
Columbia Street			13%	81%	6%																													
Stewart St		100%																																
Edgar Martinez Drive						100%																												
Elliot Avenue			21%	74%	5%																													
I-5 NB Mainline (S of Columbia)		60%					40%																											
I-5 Northbound								2%	17%	7%	3%	11%	3%	11%	31%	15%																		
I-5 SB Express Lanes (N of SR 522)																	1%	69%	15%	15%														
I-5 SB @ S. Forest	100%																																	
I-5 Southbound						100%																												
I-90 Westbound								13%	18%	3%	6%			9%							7%	35%	5%	3%										
John St			21%		9%																				70%									
Mercer Street Eastbound								100%																										
NE 42nd Street																		100%																
NE 45th Street Ramp											7%					1%										34%	43%	15%						
NE 50th Street Ramp											6%															21%	51%	22%						
S of. Royal Brougham Way															26%														25%	49%				
West Seattle Bridge EB																					9%										26%	37%	28%	
W Seattle Br EB / SR99 NB on-ramp															43%															33%				24%
SR 99 Southbound	100%																																	
Yale Avenue	100%																																	

Table 3-13: Streetlight AM O-D by Destination

ORIGIN ↓ / DESTINATION →	West Seattle Bridge WB	I-5 NB Express Lanes (N of SR 522)	S Atlantic Street Ramp	S. of Spokane St	W Seattle Br WB / SR99 SB off-ramp	I-90 Eastbound	NE 42nd Street Ramp	Edgar Martinez Drive	**Northbound I-5 CD to James**	Northbound I-5 CD to Madison Street	Mercer Street Westbound	NE 45th Street Ramp	NE 50th Street Ramp	Olive Way	**Seneca Street**	West Seattle Freeway WB	Columbia St/Cherry St (HOV only)	I-5 SB Mainline (S of Columbia)	Pike Street	Stewart Street / Eastlake Avenue	4th Avenue S	I-5 Northbound	NE 45th Street	NE 50th Street	S. of Spokane St.	6th Avenue S	Stewart Street	Union Street	John St	Western Avenue	1st Avenue S	**I-5 NB @ S. Forest**	W Seattle Br EB / SR99 NB on-ramp	John St.
1st Avenue S	49%																																	
Columbia Street			29%	62%	39%																													
Stewart St		25%																																
Edgar Martinez Drive						60%																												
Elliot Avenue			33%	38%	18%																													
I-5 NB Mainline (S of Columbia)		75%					100%																											
I-5 Northbound								21%	65%	82%	47%	100%	100%	72%	86%	100%																		
I-5 SB Express Lanes (N of SR 522)																	100%	98%	100%	100%														
I-5 SB @ S. Forest	35%																																	
I-5 Southbound						40%																												
I-90 Westbound								78%	35%	18%	46%			28%							34%	100%	100%	100%										
John St			38%		43%																				100%									
Mercer Street Eastbound								0%																										
NE 42nd Street																		2%																
NE 45th Street Ramp											4%					0%										67%	52%	47%						
NE 50th Street Ramp											3%															33%	48%	53%						
S of. Royal Brougham Way															6%														100%	63%				
West Seattle Bridge EB																					66%										100%	100%	100%	
W Seattle Br EB / SR99 NB on-ramp															8%															37%				100%
SR 99 Southbound	15%																																	
Yale Avenue	0%																																	

Table 3-14: Streetlight PM O-D by Origin

ORIGIN ↓ / DESTINATION →	**W Seattle Bridge WB**	**I-5 NB Exp Lanes**	S Atlantic Street Ramp	S. of Spokane St	W Seattle Br WB / SR99 SB off-ramp	I-90 Eastbound	NE 42nd Street Ramp	Edgar Martinez Drive	NB I-5 CD to James Street	NB I-5 CD to Madison Street	Mercer Street Westbound	NE 45th Street Ramp	NE 50th Street Ramp	Olive Way	**Seneca Street**	West Seattle Freeway WB	Pike Street	4th Avenue S	I-5 Northbound	NE 45th Street	NE 50th Street	S. of Spokane St.	6th Avenue S	Stewart Street	Union Street	John St	Western Avenue	1st Avenue S	I-5 NB @ S. Forest	W Seattle Br EB / SR99 NB on-ramp
1st Avenue S	100%																													
Columbia Street			6%	69%	25%																									
Stewart St		100%																												
Edgar Martinez Drive						100%																								
Elliot Avenue			22%	55%	23%																									
I-5 NB Mainline (S of Columbia)		84%					16%																							
I-5 Northbound								3%	14%	4%	1%	6%	3%	12%	47%	11%														
I-5 SB Express Lanes (N of SR 522)																	100%													
I-5 SB @ S. Forest	100%																													
I-5 Southbound						100%																								
I-90 Westbound								14%	15%	5%	4%			13%				9%	32%	4%	4%									
John St			31%		20%																	49%								
Mercer Street		100%																												
NE 45th Street Ramp											10%					2%							28%	32%	27%					
NE 50th Street Ramp											3%												26%	38%	32%					
Pike Street (HOV Only)		100%																												
S of. Royal Brougham Way															18%											18%	64%			
West Seattle Bridge EB																		6%										21%	44%	29%
W. Seattle Br. EB / SR99 NB on-ramp															48%												36%			
SR 99 Southbound	100%																													
Yale Avenue	100%																													

Table 3-15: Streetlight PM O-D by Destination

ORIGIN ↓ / DESTINATION →	**W Seattle Bridge WB**	**I-5 NB Exp Lanes**	S Atlantic Street Ramp	S. of Spokane St	W Seattle Br WB / SR99 SB off-ramp	I-90 Eastbound	NE 42nd Street Ramp	Edgar Martinez Drive	NB I-5 CD to James Street	NB I-5 CD to Madison Street	Mercer Street Westbound	NE 45th Street Ramp	NE 50th Street Ramp	Olive Way	**Seneca Street**	West Seattle Freeway WB	Pike Street	4th Avenue S	I-5 Northbound	NE 45th Street	NE 50th Street	S. of Spokane St.	6th Avenue S	Stewart Street	Union Street	John St	Western Avenue	1st Avenue S	I-5 NB @ S. Forest	W Seattle Br EB / SR99 NB on-ramp
1st Avenue S	16%																													
Columbia Street/Cherry Street																														
Columbia Street			16%	70%	49%																									
Stewart St		13%																												
Edgar Martinez Drive						68%																								
Elliot Avenue			30%	30%	24%																									
I-5 NB Mainline (S of Columbia)		65%					100%																							
I-5 Northbound								34%	69%	64%	32%	100%	100%	69%	90%	99%														
I-5 SB Express Lanes (N of SR 522)																	100%													
I-5 SB @ S. Forest	43%																													
I-5 Southbound						32%																								
I-90 Westbound								66%	31%	36%	42%			31%				57%	100%	100%	100%									
John St			54%		27%																	100%								
Mercer Street		17%																												
NE 45th Street Ramp											21%					1%							62%	56%	56%					
NE 50th Street Ramp											4%												38%	44%	44%					
Pike Street (HOV Only)		5%																												
S of. Royal Brougham Way															3%											100%	69%			
West Seattle Bridge EB																		43%										100%	100%	100%
W. Seattle Br. EB / SR99 NB on-ramp															7%												31%			
SR 99 Southbound	41%																													
Yale Avenue	1%																													

3.1.6 Travel Time / Speed Surveys

Travel time and speed data were collected along eight key corridors in the study area using a floating car enabled with GPS-collection devices. These devices capture location and speed every five-seconds to identify the length and duration of queues throughout the downtown street grid.

Travel time runs were completed throughout the AM, MD, and PM peak periods, completing as many routes as possible during the period. Due to varying levels of congestion and length of the routes, the number of runs completed along each route by direction and by time of day ranges from four to twenty runs. Travel time runs were completed over multiple days during the middle of the week, with runs being conducted along the SR 99 every day to ensure a consistent sample along that route was collected.

Table 3-16 provides a list of the travel time run corridors, **Table 3-17** displays the number of travel time runs completed along each route by time period, and **Figure 3-11** shows the travel time run corridors on a map.

Table 3-16: Travel Time Run Corridors

Number	Path	Extents
1	NB: 1st Ave to Battery St	Spokane Street to Denny Way
	SB: Wall Street to 1st Ave	Denny Way to Spokane Street
2	NB: 4th Ave S/4th Ave to Battery St	Spokane Street to Denny Way
	SB: Wall St to 2nd Ave/4th Ave S	Denny Way to Spokane Street
3	NB: 5th Ave S/5th Ave to Westlake Ave	Dearborn Street to Denny Way
	SB: Westlake Ave to 5th Ave/5th Ave S	Denny Way to Dearborn Street
4	NB: I-5 (express lanes when possible)	Spokane St Ramp to Lake City Way
	SB: I-5 (express lanes when possible)	Lake City Way to Spokane St
5	NB & SB: Boren Avenue	Yesler Way to Denny Way
6	EB: Spring Street	Western Avenue to Broadway
	WB: Madison Street	Broadway to Western Avenue
7	SR 99	
8	West Seattle Bridge	SR 99 to West Seattle Bridge Terminus

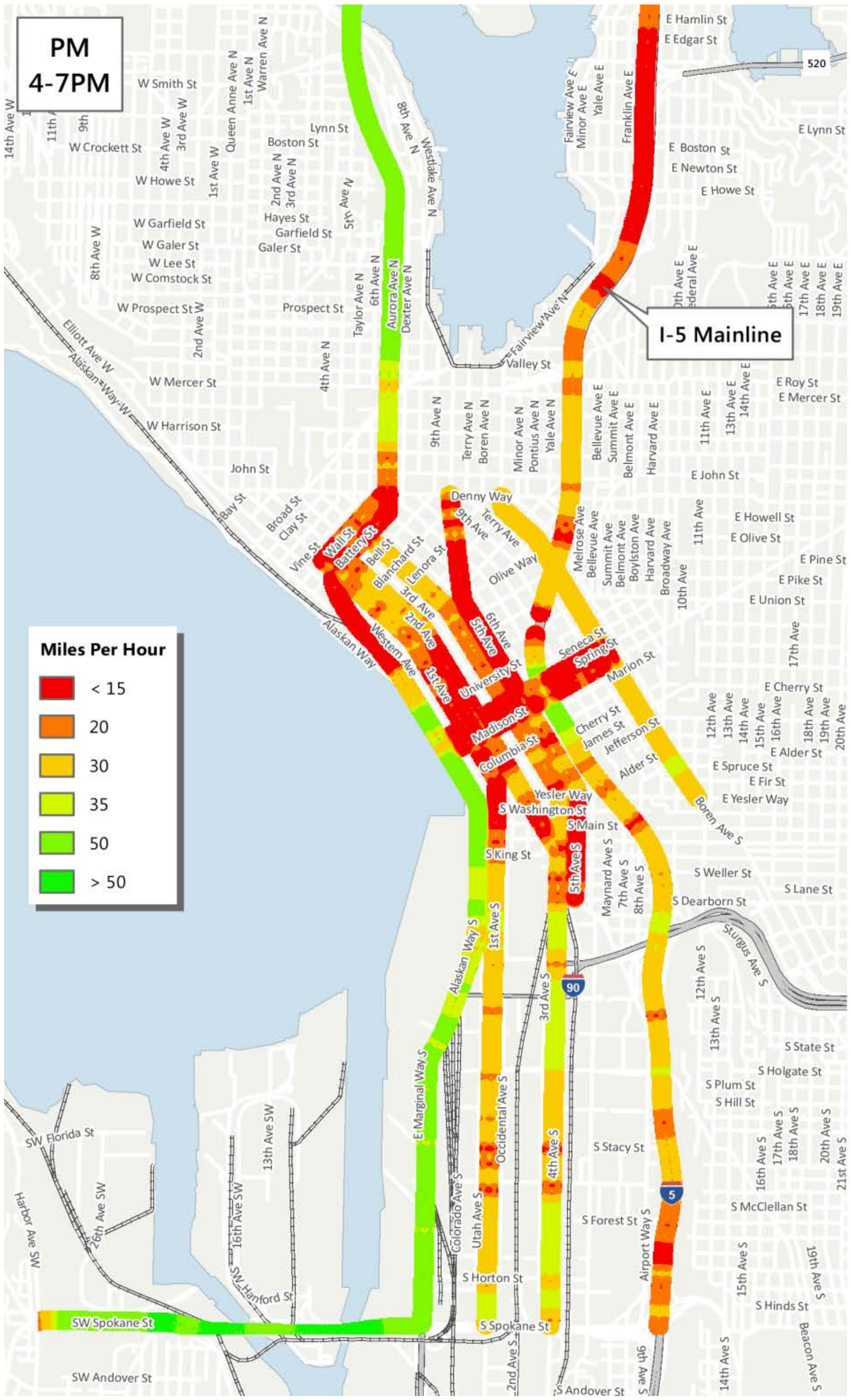
Table 3-17: Number of Travel Time Runs by Route and Time Period

Route	AM		MD		PM	
	NB/EB	SB/WB	NB/EB	SB/WB	NB/EB	SB/WB
1: 1st Ave	4	4	3	3	5	4
2: 2nd/4th Aves	5	5	4	4	5	5
3: 5th Ave	-	7	-	5	-	6
4: I-5	5	6	4	3	4	3
5: Boren Ave	8	8	6	5	7	7
6: Spring/Madison Aves	9	8	7	7	12	12
7a: SR 99	5	4	5	4	20	21
7b: SR 99	4	5	5	5	5	5

Figure 3-11: Travel Time Run Corridors

I-5 experiences the slowest travel speeds into downtown during the PM peak period, with speeds no greater than 30 mph, and as low as 15 mph in some sections. **Figure 3-12** shows very slow speeds on SR-99 north of downtown and south of Denny Way. The 1st and 4th Avenue arterials operate at speeds between 15 and 35 mph.

Figure 3-12: PM Travel Speeds into Downtown

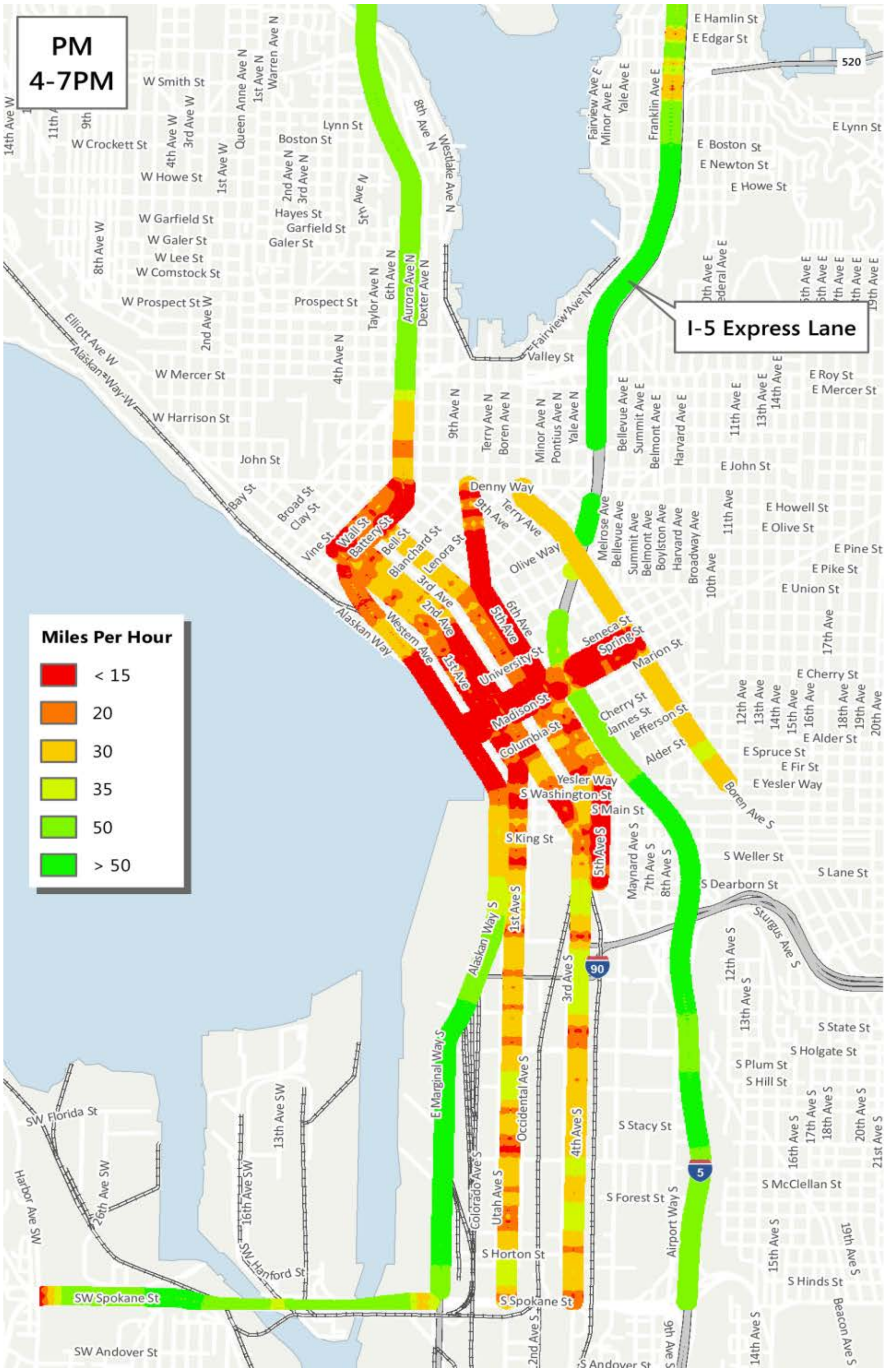


PM travel speeds within downtown do not exceed 20 mph in most locations as shown in **Figure 3-13**. The roadways surrounding the Central Business District operate at slightly higher speeds: between 15 and 30 mph. SR-99 within the downtown area is congested and operates at speeds less than 15 mph.

Figure 3-13: PM Travel Speeds within Downtown

Travel speeds on SR-99 and I-5 leaving downtown Seattle in the PM peak period range between 35 and 50+ mph. The 1st and 4th Avenue arterials generally operate between 30 and 35 mph with pockets of 20 mph or below. Speeds within downtown remain at 30 mph or below as shown in **Figure 3-14**.

Figure 3-14: PM Travel Speeds Leaving Downtown



3.1.7 Intersection Geometries and Signal Timings

To make sure that the DTA model is accurately reflecting travel conditions along parallel routes in downtown Seattle, it is important to obtain the latest signal timing plans for intersections along potential diversionary routes. The consultant team worked with the City of Seattle DOT to ensure that the latest signal timing plans are incorporated into the DTA model. This allows for accurate modeling of potential delay caused by signalized intersections in the downtown area.

In addition, field observations were conducted to ensure that intersection geometries and characteristics (number of lanes, turning restrictions, etc.) are accurately coded in the DTA model.

4.0 SOCIOECONOMIC VARIABLES AND LAND USE

BERK Consulting conducted an independent review of available regional and subarea land use forecast products for Central Puget Sound region. The purpose of this review was to assess whether adjustments would be necessary to develop a revised forecast data product that is suitable to inform the development of investment grade quality traffic and revenue estimates to support the financing of the SR 99 project. When necessary, BERK performed additional analysis to prepare land use forecast data for all census tracts in the Central Puget Sound region. This chapter describes the review, key findings, and analysis steps taken to develop an independent land use forecast product covering the years 2010, 2015, 2020, and 2040.

4.1 DATA AND FORECAST PRODUCTS REVIEWED

Table 4-1 shows the data and forecast products reviewed by BERK for this study, organized by forecast year, land use type, and area covered (inside vs. outside the City of Seattle). Each data product is described below.

Table 4-1: Small Area Land Use Products Reviewed

Forecast Year	Land Use Type	Inside Seattle	Outside Seattle
2010	Employment	PSRC Total Estimated Employment by census tract (2010)	PSRC Total Estimated Employment by census tract (2010)
	Population and Households	PSRC Land Use Targets forecast (MR1)	PSRC Land Use Targets forecast (MR1)
2015	Employment	PSRC Total Estimated Employment by census tract (2010 and 2013); and City of Seattle Comp Plan, 2015	PSRC Total Estimated Employment by census tract (2010 and 2013); PSRC Land Use Vision (LUV.0) (2020)
	Population and Households	City of Seattle Comprehensive Plan, 2015; OFM Housing and Population Estimates, 2015	PSRC Land Use Targets forecast (MR1); PSRC Land Use Vision (LUV.0); PSRC Residential Building Permits (2010-2013); OFM Housing and Population Estimates, 2015
2020/2040	Employment	City of Seattle Comprehensive Plan, 2015 preferred alternative growth targets; PSRC LUV 1.0 2025/2040	PSRC LUV 1.0 2025/2040
	Population and Households	City of Seattle Comprehensive Plan, 2015 preferred alternative growth targets; PSRC LUV 1.0 2025/2040	PSRC LUV 1.0 2025/2040

4.1.1 PSRC 2015 Regional Macroeconomic Forecast

PSRC's macroeconomic forecast provides annual regional totals of households, population, and employment through 2040. It serves as a key input into PSRC subarea land use forecasting efforts. BERK used this forecast to develop region-wide 2015, 2020, and 2040 control totals for households, household population, group quarters population, and employment by sector.

4.1.2 PSRC Total Employment Estimates by Census Tract

PSRC provided BERK with two custom employment data products for use in this forecasting study: total employment summaries by census tract for 2010 and 2013. Each spreadsheet includes employment in six sectors by census tract for the entire PSRC region (King, Kitsap, Pierce, and Snohomish counties). Total estimates include covered employment counted in the Quarterly Census of Employment and Wages as well as several categories of non-covered employment including unincorporated self-employed individuals[1]. Missing from these data were estimates of uniformed military employment, which were provided separately. These data were reviewed by BERK for use in the 2010 and 2015 forecast products. As part of the review, BERK interviewed staff at PSRC to better understand PSRC's method for developing and ensuring the quality of this data product.

One significant limitation of these data is PSRC's practice of suppressing data values for particular sectors to protect confidentiality in accordance with state and federal laws. The SR 99 study requires land use inputs for all sectors and all census tracts. It was necessary, therefore, to conduct additional analysis to estimate employment by sector in cases where PSRC had suppressed data values. This analysis is described later in this chapter.

4.1.3 PSRC Estimated Growth Capacity by Parcel

PSRC shared data about growth capacity estimates by parcel used to develop PSRC's small area forecast products. These data include total post-2010 growth capacity for residential (in units) and non-residential (in net square feet) land uses based on an analysis of city and county zoning and existing conditions. This parcel data also includes existing (2010) units and net non-residential square footage, maximum dwelling units per acre, and maximum floor area ratio.

4.1.4 PSRC Land Use Vision Forecast (LUV)

PSRC's latest land use forecast product, Land Use Vision (LUV) version 1.0 was released in September 2015. Methodology documentation is available on the PSRC website. PSRC provided BERK with additional custom data products that are consistent with the publicly available LUV forecast: military employment by tract and household income breakdowns by tract. LUV combines military employment into the Government/Higher Education sector category. Therefore, BERK separated out military for review and analysis.

4.1.5 PSRC Residential Building Permits

PSRC releases annual reports of permitted new residential units, demolitions/lost units, and net total units[2]. Estimates are reported by both housing type and census tract. BERK analyzed permit

---

1 For more information about PSRC's employment data products, including Total Employment Estimates, see the technical memo titled Employment Data Series located at http://www.psrc.org/assets/4000/emp_data_series.pdf.

2 For more information, see http://www.psrc.org/data/pophousing/permits.

data for the years 2010 – 2013 to help determine distribution of recent residential growth after the 2010 baseline.

4.1.6 Washington State Office of Financial Management April 1 Official Population Estimates and Small Area Estimates

The Office of Financial Management (OFM) provides annual estimates of population and housing units for the years 2000 through 2015 by county and jurisdiction as well as small area geographies including census tract. These estimates are based upon an analysis of best available data for the county in question, including residential building permits, assessor records, postal delivery statistics, and federal census data[3]. These data were reviewed for baseline population and housing counts.

4.1.7 City of Seattle Comprehensive Plan, Land Use by TAZ

For its 2015 Comprehensive Plan, the City of Seattle prepared housing, population, and employment estimates for 2015 by Seattle transportation analysis zone (TAZ). The City also prepared their Preferred Alternative housing and employment growth targets by TAZ for the 20-year planning period. This data is not in public release and was shared with BERK for use in this project.

Staff from the City of Seattle provided BERK with a spreadsheet summarizing new housing unit growth from 2010 – 2015, as well as permitted and master planned units expected to be completed after 2015, by Seattle TAZ. This spreadsheet was developed by the City for use in developing the 2015 Comprehensive Plan land use data and is not in public release. BERK corresponded with City of Seattle staff extensively while assessing the quality and utility of this data.

4.2 2010 BASELINE DATA REVIEW AND PREPARATION

4.2.1 2010 Households and Population

PSRC's Land Use Vison forecast provides housing units, households, household population, group quarters population, and total population by census tract for 2010. To review this product BERK compared the household and population totals by tract to the 2010 decennial census. Values for all tracts were found to be within 0.01% of the census counts on average. Based on this review, BERK deemed the 2010 forecast to be reliable and used the data without modification.

[3] For more information, see http://www.ofm.wa.gov/pop/april1/ and http://ofm.wa.gov/pop/smallarea/default.asp.

4.2.2 2010 Employment

The PSRC Total Employment Estimates by Census Tract for 2010 include total employment counts and breakdowns by six job categories:

- Construction/Resource
- Manufacturing, Warehousing, Transportation, and Utilities
- Retail and Food Services
- Finance, Insurance, Real Estate, and Other Services
- Government and Higher Education
- K-12 Education

Based on BERK's research and interviews with PSRC and City of Seattle staff, this dataset is the best available estimate of total employment by subarea for the Central Puget Sound Region; however, there are known limitations. The first limitation is missing categories of employment. The primary source of PSRC employment counts is the Quarterly Census of Employment and Wages, a dataset controlled by the Washington State Employment Security Department (ESD) and generated from unemployment insurance reporting requirements. Some categories of jobs are exempt from reporting and therefore missing from the database: unincorporated self-employed, jobs paid only by commission, corporate officers, uniformed military, elected officials, church jobs, and railroad workers. The Bureau of Labor Statistics estimates that exempt jobs add up to approximately 8 percent of all employment[4]. According to PSRC, they correct for this problem by drawing from the American Community Survey (ACS) estimates of non-incorporated self-employment and Department of Defense data for ununiformed military employment. Corporate officers are located by scaling covered workplace records.

The second primary limitation of PSRC's Total Employment Estimates is ambiguity with regards to workplace locations for some employers. For instance, in cases where a business or public sector entity has multiple workplace locations, the information reported to ESD by employers commonly assigns all workers to the headquarters location. According to PSRC, they partially correct for this problem through a periodic survey of public sector employers[5], the Boeing Company, and Microsoft to disaggregate headquarters employment to actual workplace locations. PSRC also disaggregates workplace employment based on available public information for approximately 40 private and non-profit companies.

BERK mapped the PSRC data by census tract and reviewed the distribution of employment by sector for reasonableness with the above limitations in mind. Areas known to have large employment concentrations (e.g., the Everett Boeing plant, downtown Seattle, Seattle-Tacoma International Airport) were specifically reviewed to ensure that employers with multiple locations were adequately accounted for. No major anomalies were apparent from this analysis.

BERK also conducted additional analysis to develop estimates to replace suppressed data values. First, a SR 99 project team collaborator provided BERK with a separate 2010 baseline employment dataset by PSRC TAZ. This dataset was developed using 2010 covered employment by tract, as well as factors for scaling tract employment by NAICS code to estimate total employment. Additionally, this dataset filled in suppressed data values using 2009 covered employment estimates that were not subject to confidentiality laws. BERK used this collaborator's baseline dataset to develop replacement values for suppressed data in the PSRC estimates and

[4] Based on Bureau of Labor Statistics (BLS) estimates; see http://www.bls.gov/cew/cewbultn.htm.

[5] Based on data provided by PSRC, there were 159 public sector employers who have responded to PSRC's survey. City of Seattle, Port of Seattle, and King County all appear on the list of survey respondents provided to BERK.

adjusted suppressed sector totals proportionally to conform to PSRC total employment counts by tract.

This additional data was not available to estimate the distribution of Construction sector jobs. Suppressed values for this sector were distributed in proportion to total county jobs to reach control totals. For all other sectors, where 2010 values were suppressed, the distribution of their 2009 values were used to allocate the discrepancy between PSRC 2010 totals and unsuppressed sectors. In cases where the total discrepancy was not known (total jobs were suppressed), the 2009 unsuppressed values were directly substituted. Where tract totals exceeded PSRC control totals, excess jobs were removed from the Construction sector. Finally, minor adjustments were made within tracts to match sector control totals for each county. Where multiple sectors were originally unknown, jobs were shifted from over-estimated to under-estimated sectors, maintaining tract control totals.

Military jobs by tract were estimated by tract by scaling the LUV.0 2020 estimates by tract to conform to the 2010 county-wide control totals provided by PSRC.

4.3 2015 BASELINE DATA REVIEW AND PREPARATION

4.3.1 2015 Households and Population

BERK reviewed OFM's small area estimates released in fall 2015, including all associated methodological and user documentation. These data were deemed the best available source for 2015 population, households, and housing units outside of the City of Seattle. These estimates are consistent with the city, county, and regional control totals described below. For tracts within the City of Seattle, BERK used a different method described below.

4.3.2 Regional control totals

BERK used PSRC's 2015 Macroeconomic Forecast for a 2015 regional control total. The 2015 OFM Official Population Estimates by county were used to distribute the PSRC regional control total proportionally. These were taken directly from the 2015 Washington State Office of Financial Management April 1 Official Population Estimates[6]. **Table 4-2** shows the control totals and estimated population growth for each county. This table also breaks down total estimated 2015 population into group quarters population[7] and household population.

[6] http://www.ofm.wa.gov/pop/april1/default.asp

[7] PSRC's 2015 Macroeconomic Forecast projects 2015 group quarter population for the region. BERK used this projection as a control total along with the PSRC LUV.0 2020 forecast to estimate group quarter counts by tract and aggregate up to the county. This enabled the development of household population control totals by county that are consistent with the total population control totals above

Table 4-2: Population Estimates by County and City of Seattle

County	2010	2015	Total Growth (2010 to 2015)	Group Quarters Population (2015)	Household Population (2015)
King	1,931,253	2,076,908	145,655	41,655	2,035,254
Kitsap	251,132	261,232	10,100	9,781	251,452
Pierce	795,225	839,869	44,644	20,132	819,738
Snohomish	713,338	766,497	53,159	11,663	754,835
Total	3,690,948	3,944,506	253,558	83,231	3,861,279
City of Seattle	608,660	662,400	53,740	27,958	634,442

Source: Washington Office of Financial Management, 2015; PSRC 2015; BERK 2015

Table 4-3 shows housing unit control totals.

Table 4-3: Housing Unit Estimates by County and City of Seattle

County	2010	2015	Total Growth (2010 to 2015)
King	851,261	893,324	42,063
Kitsap	107,367	109,864	2,497
Pierce	325,375	337,888	12,513
Snohomish	286,659	300,724	14,065
Total	1,570,662	1,641,800	71,138
City of Seattle	308,455	332,694	24,239

Source: Washington Office of Financial Management, 2015

4.3.3 Determine subarea housing growth in Seattle

The City of Seattle provided BERK with estimated housing unit growth from 2010 – 2015 for the Seattle TAZ. This data was prepared in 2014 for the 2015 Seattle Comprehensive Plan. BERK used GIS to summarize this data by tract and added it to 2010 housing unit counts to determine total housing units by tract. The total five-year growth estimated by the City in 2014 was less than the total growth later estimated by OFM. To fill the gap, additional units were added proportionally in tracts where PSRC housing permits issued 2010 – 2013 exceeded total housing unit growth estimated by the City.

4.3.4 Calculate number of households

Housing vacancy rates decreased throughout the region between 2010 and 2015. BERK used housing market survey data from Dupre and Scott[8] (shown in **Table 4-4**) to determine the percent change in March vacancy rates for each county between 2010 and 2015. These percent changes were then used to adjust 2010 tract level vacancy rates in Seattle to determine the total number of households per tract based on 2015 housing unit counts.

[8] See http://www.duprescott.com/publications/theApartmentVacancyReport.cfm.

Table 4-4: Apartment Vacancy Rates by County

County	March 2010	March 2015	% Change
King	6.0%	3.5%	-41.7%
Kitsap	7.6%	3.7%	-51.3%
Pierce	5.7%	4.3%	-24.6%
Snohomish	7.5%	2.4%	-68.0%

Source: Dupre and Scott, 2015; BERK 2015

4.3.5 Calculate preliminary household population

Household population in Seattle tracts were calculated in two steps. First, household population in units that existed in 2010 were calculated based on 2010 average household sizes by tract. Second, households in new units were divided into multi-family and single family based on percentage shares from PSRC residential permit data. For these households, population was calculated using revised tract-level household size estimates for multi-family and single family households from the 2013 American Community Survey[9].

4.3.6 Interpolate group quarter population from PSRC forecasts

PSRC’s Land Use Targets forecast includes group quarter population counts by tract for 2010. PSRC’s Land Use Vision forecast includes group quarter population counts by tract for 2020. To estimate counts for 2015, BERK interpolated the difference between 2010 and 2020 using the PSRC region-wide forecast for 2015 group quarter population as the control target.

4.3.7 Adjust household population totals to conform to regional controls

The method above resulted in total King County population slightly in excess of projected control totals. Therefore a final step was to scale down household population proportionally.

4.4 2015 EMPLOYMENT

The only available source of 2015 employment by tract came from Seattle’s Comprehensive Plan work. BERK reviewed this data for reliability and analyzed additional data sources to develop a new 2015 forecast product for the entire region. The steps taken in this analysis are described below.

4.4.1 Regional control totals

The first step was to project 2015 employment by county and sector for 2015. These values are used as regional control totals to which tract level changes in employment must conform. For regional control totals, BERK used PSRC’s 2015 Macroeconomic Forecast. BERK then analyzed 2010 and 2013 total employment estimates by county from PSRC to calculate relative rates of

[9] The ACS provides tract-level estimates for average size of renter and owner-occupied homes. These figures were used as proxies for multi-family and single family homes. ACS estimates are prone to having a large margin of error. In instances where renter household size is greater than 2010 average household size, the 2010 average household size was applied to all homes.

change by county and employment sector, as shown in **Table 4-5**. BERK also analyzed non-farm employment data from the ESD to calculate 2013 – 2015 growth rates by county[10].

In conjunction, these two reference points were used to estimate relative rates of growth by county and sector for 2013 – 2015, assuming sector growth trends from 2010-2013 continue. These relative rates of growth were then used to develop preliminary projections for 2015 employment by county and sector. Finally, these preliminary projections were scaled to conform to the regionwide control totals from PSRC's Macroeconomic Forecast. The final results are shown in shown in **Table 4-6**.

Table 4-5: Estimated Employment Annual Growth Rates by Sector and County (2010-3)

County	Construction/ Resource	Manufacturing/ WTU	Retail/Food Services	FIRE/Other Services	Government/ Higher Ed.	K-12	Total
King	1.92%	1.90%	4.38%	3.02%	0.45%	0.69%	2.63%
Kitsap	-1.24%	2.59%	0.05%	0.60%	-0.79%	-1.99%	0.37%
Pierce	-0.52%	5.53%	2.54%	1.25%	-0.84%	-1.32%	1.50%
Snohomish	0.62%	7.23%	3.88%	4.55%	-1.44%	-0.70%	4.04%
Total	1.03%	3.49%	3.75%	2.86%	-0.09%	-0.22%	2.55%

Source: BERK analysis of PSRC employment data, 2015

Table 4-6: BERK 2015 Employment Projections

County	Construction/ Resource	Manufacturing/ WTU	Retail/Food Services	FIRE/Other Services	Government/ Higher Ed.	K-12	Military	Total
King	73,211	221,676	229,154	687,401	127,930	49,550	580	1,389,502
Kitsap	5,519	16,463	18,434	37,749	11,292	6,607	7,882	103,946
Pierce	24,681	47,942	62,283	131,293	40,045	21,611	36,247	364,102
Snohomish	24,677	84,052	59,585	117,002	21,608	16,539	4,711	328,174
Total	128,088	370,133	369,456	973,445	200,875	94,307	49,420	2,185,724

Source: BERK, 2016

Table 4-7 compares the total employment growth rates by county projected by BERK to PSRC estimates for 2010 – 2013, PSRC LUV 1.0 (2010 – 2025), and regional employment growth projected by the PSRC Macroeconomic Forecast.

[10] King and Snohomish counties were combined in this dataset requiring further analysis to estimate the growth rates for each county individually.

Table 4-7: Comparison of Average Annual Employment Growth Rates

County	PSRC Total Employment Estimates 2010 - 2013	BERK 2013 - 2015	PSRC LUV 1.0 2010 - 2025
King	2.63%	4.20%	1.77%
Kitsap	0.37%	3.24%	1.29%
Pierce	4.04%	4.65%	1.30%
Snohomish	1.50%	5.00%	1.84%
Total	2.55%	4.35%	1.68%
PSRC 2015 Macroeconomic Forecast	2.40%	4.47%	1.68%

4.4.2 Subarea estimates

BERK used PSRC's 2013 employment estimates by tract as the base for 2015 subarea estimates[11]. While generally consistent with recent commercial development trends, BERK's tract-level review of PSRC's 2010, 2013, and 2014[12] total employment estimates revealed some instances of inconsistencies. For instance, total employment for some tracts rose significantly in 2013 only to fall again significantly in 2014. For this reason BERK did not consider employment growth rates at the tract level when determining the allocation of growth to reach 2015 control totals. Instead, the remaining increment of employment growth was allocated to tracts using a combination of data sources. For King County, BERK first analyzed assessor data to summarize net square footage of non-residential construction by land use category built 2013 to 2015. Standard employment density factors were then used to estimate new employment by sector[13]. The sum of this growth did not exceed projected King County employment growth in any sector. Therefore, the remaining increment of growth was allocated to tracts proportionally based on each tract's relative share of total employment growth by sector in 2014. For the other three counties, all projected growth beyond 2013 was allocated based on each tract's relative share of county-wide employment, by sector in 2014.

The preliminary growth estimates were then compared to estimated employment growth capacity by tract. Total employment growth in excess of estimated capacity and absorption through filling of vacancy[14] was reallocated to tracts with spare growth capacity and additional growth forecasted for 2020 by PSRC.

The results of this analysis were then summarized by PSRC's forecast analysis zones and compared to forecasted employment growth from the PSRC Land Use Vison forecast. BERK

[11] Like the 2010 PSRC employment estimates, the 2013 estimates also featured suppressed sector totals. To address this, BERK replaced suppressed totals with 2010 data and allocated the remaining discrepancy to suppressed job sectors (proportionally, based on 2010 sector estimates), by tract.
[12] 2014 employment estimates arrived very late in the analysis and were not thoroughly reviewed. Therefore, 2013 was maintained as the baseline from which BERK grew to 2015.
[13] Growth in construction employment was allocated to tracts proportionally to the total volume of construction 2013-2015 found in BERK's analysis of King County assessor data.
[14] Colliers International reports office vacancy rates in the Puget Sound Region declining from over 16% in 2010 to approximately 10% in 2015. They also report industrial vacancy rates declining from over 9% to less than 4% over the same period. See reports at http://www.colliers.com/en-us/seattle/insights

mapped instances of projected 2015 growth exceeding the 2035 totals from PSRC's forecasts to determine if the instances could be explained.

4.5 2020 AND 2040 FORECAST DATA REVIEW AND PREPARATION

In reviewing PSRC's population and employment growth forecasts, BERK began with the presumption that the Land Use Vision and Macroeconomic Forecasts released by PSRC provide adequate regional control totals for population and employment. Therefore, the focus of this study was the distribution and timing of growth between counties and sub-areas of the region.

4.5.1 Household and Population Forecast

Table 4-8 shows a comparison of historic and forecasted population growth rates for each county in the PSRC region as well as the City of Seattle. The table shows that during the first five years of PSRC's 2010 – 2025 forecast period, population grew considerably slower in Kitsap and Pierce counties than forecasted while it grew faster than forecasted in King County and the City of Seattle. Looking ahead, the City of Seattle permit data indicates a healthy pipeline of net new residential units (9,258) and no clear sign of a short-term slowdown in construction activity. To reflect these trends, BERK made some adjustments to the PSRC growth rates by county when developing its revised 2015 – 2020 forecasts. These adjustments reallocate some forecasted growth for Kitsap and Pierce to King. BERK also reallocated some Kitsap growth for the 2020 – 2040 period to King County. Total population growth forecasts for Snohomish and Pierce counties remain unchanged. The growth rates in BERK's forecast, however, are different, reflecting variations in the amount of PSRC's forecasted growth that has already occurred.

Table 4-8: Population Growth Rate Comparison

County	OFM (Estimated)		PSRC LUV 1.0 Forecast		BERK Forecast	
	2000 - 2010	2010 - 2015	2010 - 2025	2025 - 2040	2015 - 2020	2020 - 2040
King	1.06%	1.23%	0.97%	0.53%	1.04%	0.58%
Kitsap	0.80%	0.56%	1.25%	1.08%	0.95%	1.10%
Pierce	1.28%	0.86%	1.25%	0.92%	1.25%	1.05%
Snohomish	1.64%	1.21%	1.19%	0.86%	1.20%	0.91%
Total	1.20%	1.10%	1.09%	0.72%	1.11%	0.78%
PSRC 2015 Macroeconomic Forecast	1.20%	1.29%	1.08%	0.76%	1.11%	0.81%
City of Seattle	0.78%	1.71%	1.08%	0.58%	1.13%	0.62%

Source: BERK, 2016 based on data from Washington State OFM, 2015 and PSRC, 2016

Table 4-9 shows BERK's population forecast for 2020 and 2040, compared to PSRC's LUV 1.0 forecast[15]. 2020 reflects faster than forecasted growth in King County between 2010 and 2015 and slower than forecasted growth in Kitsap and Pierce counties. While Kitsap is forecasted to grow at the fastest rate of all counties between 2020 and 2040, BERK's forecasted total for Kitsap in 2040 is less than forecasted by PSRC.

[15] PSRC Regional Macroeconomic Forecast used for 2020 regional total. LUV 1.0 interpolated county totals used to calculate county and Seattle shares of regional total. 2040 PSRC based on LUV 1.0.

Table 4-9: Population Forecast Comparison

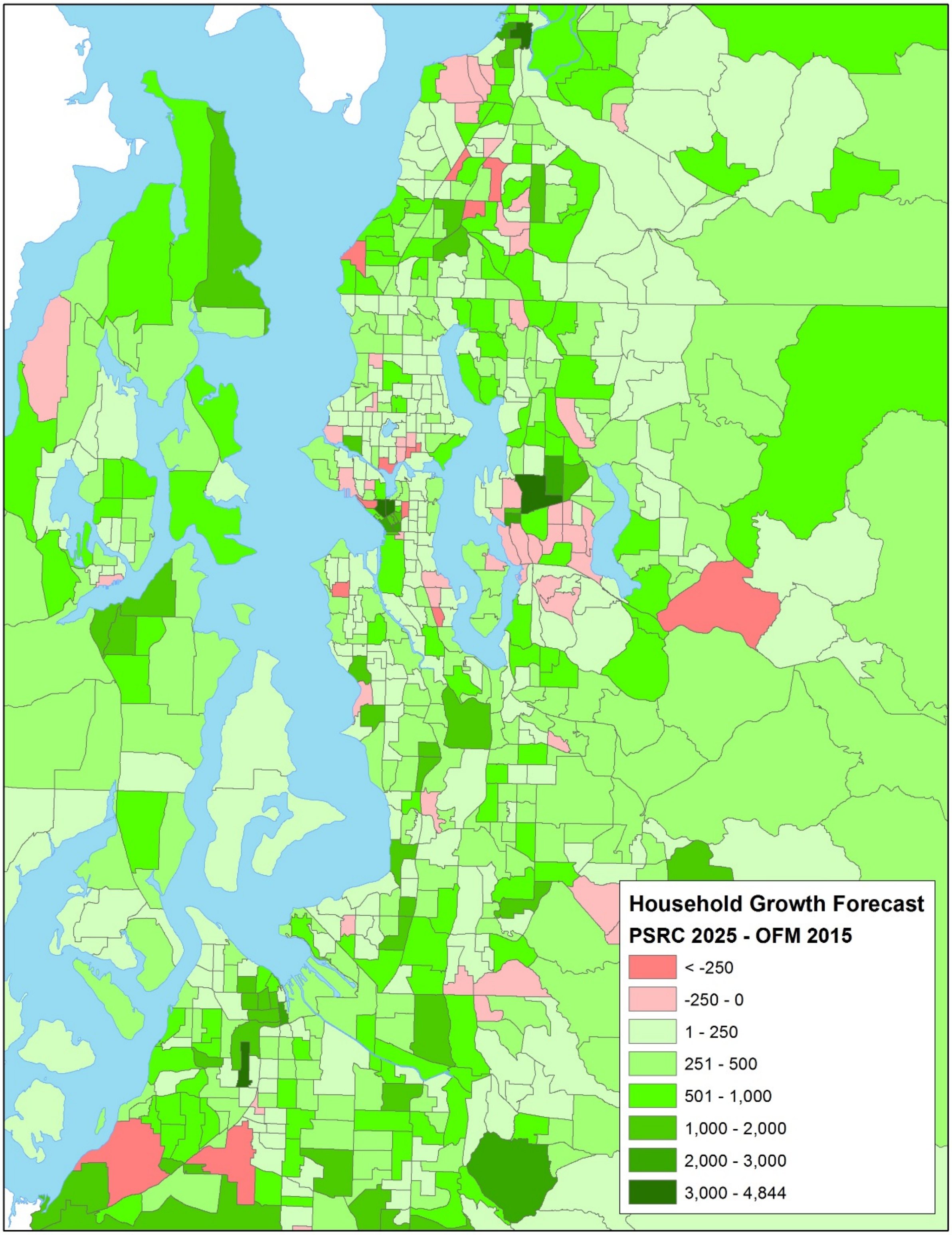
County	2020			2040		
	PSRC Macro.	BERK	% Diff.	PSRC LUV 1.0	BERK	% Diff.
King	2,152,799	2,187,094	1.6%	2,428,667	2,456,068	1.1%
Kitsap	288,381	273,879	-5.0%	360,281	340,864	-5.4%
Pierce	913,229	893,690	-2.1%	1,109,294	1,101,294	-0.7%
Snohomish	813,858	813,604	0.0%	974,720	974,720	0.0%
Total	4,168,267	4,168,267	0.0%	4,872,962	4,872,946	0.0%
City of Seattle	679,131	700,759	3.2%	785,119	792,903	1.0%

Source: PSRC, 2015; BERK, 2016

4.5.2 Subarea Forecast Review

Upon initial review of the LUV 1.0 tract level population and household estimates BERK discovered several examples in which the 2025 population and household forecasts were significantly lower than OFM 2015 small area estimates. These findings are mapped in **Figure 4-1.**

Figure 4-1: PSRC LUV 1.0 Household Forecast Comparison to OFM Estimates



In many of these cases both population and household counts grew steadily in later forecast periods. In all instances PSRC's 2010 estimates are consistent with the 2010 Census. BERK analyzed employment forecasts to see if significant redevelopment is expected in the tract, which may explain the loss of housing. This doesn't appear to explain any instances[16]. BERK also reviewed group quarter population growth forecasts to see if some households were being converted to or reclassified as group quarter housing in later forecasts, which may explain two tracts containing the Joint Base Lewis McChord in Pierce County. Finally, BERK also reviewed aerial photography of a sample of tracts in Google Earth to see if they appear to be likely candidates for significant planned redevelopment. For tracts showing this discrepancy inside the City of Seattle, BERK deferred to the City of Seattle 2015 Comprehensive Plan forecast, described below. In other areas, when no explanation could be identified BERK assumed no loss of population or housing following the 2015 estimate[17].

Special attention was given to forecasting growth within the City of Seattle, due to its central significance to SR 99 travel volumes. Planners from Seattle provided TAZ-level housing unit and employment growth targets for 2015 - 2035 from the Comprehensive Plan. While the total growth over the period is consistent with LUV 1.0, the distribution of growth within the city is different. Additionally, BERK's forecast begins with a higher 2015 households and population than found in a linear interpolation of data from LUV 1.0.

To determine household sizes within the City of Seattle, BERK analyzed recent development trends to determine the percentage of new units that are multi-family and single family, then used 2010 Census estimates of household size by housing tenure (owner vs renter) as a proxy for the differences in housing size between single family and multi-family[18]. Using these household size assumptions, BERK calculated preliminary household population growth by tract. For tracts outside of Seattle, BERK used PSRC average household size assumption by tract to calculate household population.

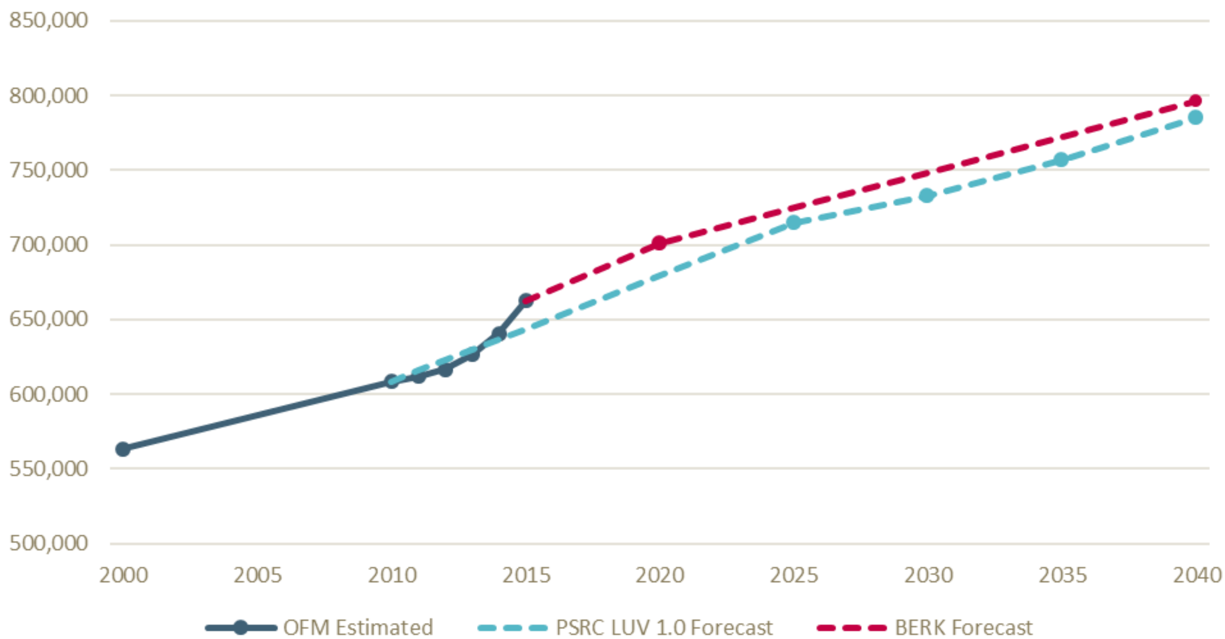
Figure 4-2 shows BERK's forecast for the City of Seattle compared to LUV 1.0. Total estimated population for 2000 – 2015 is also included for context.

[16] The only examples of significant forecasted employment growth between 2010 and 2025 were on military bases, which appears to be explained by inconsistencies with regards to the inclusion of military jobs in total employment counts. PSRC documentation indicates an assumption of 0 military employment growth in the LUV 1.0 forecast.

[17] BERK also contacted PSRC forecasting staff for an explanation of these inconsistencies. Rebeccah Maskin indicated that the loss of households in all identified instances was not deliberate and rather an artifact of how the model deals with interim (pre-2040) forecasts. She advised that no loss of households should be assumed.

[18] The Census does not provide breakdowns for average household size by units in structure. So average household size by housing tenure (owner vs. renter) was used as proxy for single family and multi-family. In rare instances where the average household size for renter households is higher than the tract average household size, the tract average was applied to all new housing. BERK compared the resulting average household size by tract and citywide to the regionwide decline in household size forecasted in the PSRC Macroeconomic Forecast and found consistency.

Figure 4-2: Seattle Population Forecast Comparison



Source: OFM, 2015; PSRC, 2016; BERK, 2016

The City of Seattle provided TAZ-level summaries of net new housing units permitted but not yet built in 2015. BERK assumed all permitted units would be built and occupied by 2020. **Figure 4-3** compares recent residential new construction permit activity to housing growth targets in Seattle's 2015 Comprehensive Plan. BERK reviewed this data to evaluate general consistency between comprehensive plan growth targets and recent market activity, particularly with regards to growth expected in the short term (2015 – 2020). For tracts with little or no permitted units in 2015, BERK assumes a greater share of anticipated growth will occur during the 2020 – 2040 period. An example is growth near the planned 145th Street light rail station due to open in 2023.

The SR 99 uses summary districts for comparing land use forecasts. Districts 1-14 include the City of Seattle and neighboring areas to the southwest including Burien and SeaTac. **Figure 4-4** show a comparison of forecasted households in these districts. The BERK forecast shows slighter more growth in these districts than forecasted by PSRC in LUV 1.0.

Figure 4-3: City of Seattle Housing Growth Targets Compared to Recent Permit Activity

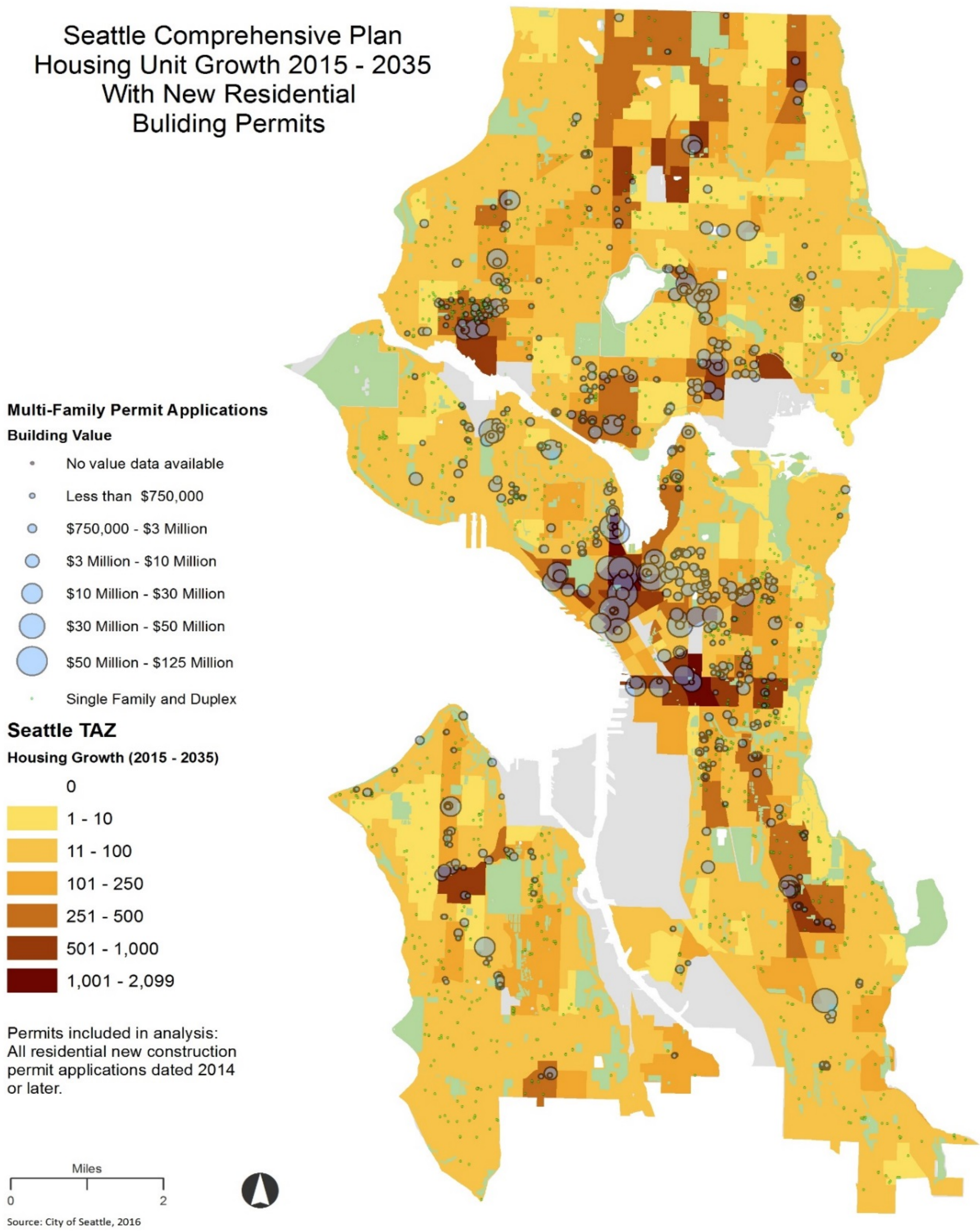
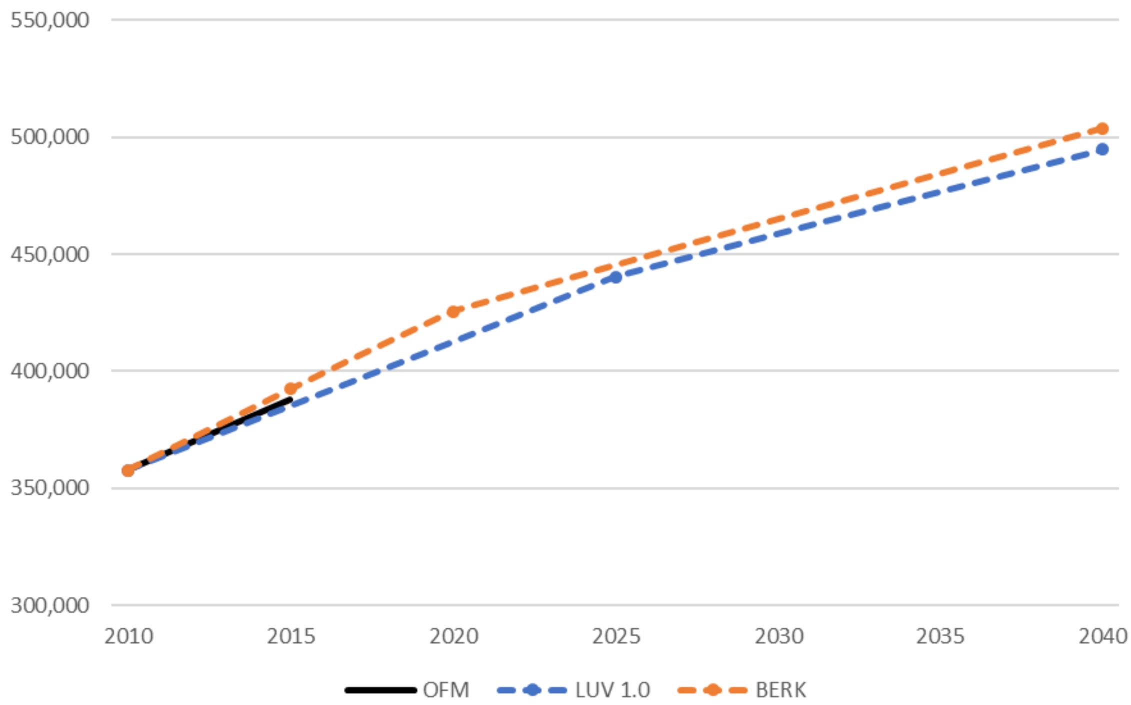


Figure 4-4: Household Forecast Comparison (Districts 1-14)



Source: PSRC 2015, BERK 2016

4.5.3 Employment Forecasts

PSRC's 2015 Macroeconomic Forecast provides regional total employment by year and job sector. BERK used these estimates for the 2020 regional control totals. To develop preliminary breakdowns of regional employment by county, BERK interpolated shares of regionwide employment by county using PSRC's 2013 Total Employment Estimates and LUV 1.0 forecast for 2025. BERK also compared historic and forecasted rates of total employment growth by county. **Table 4-10** shows this growth rate comparison as well as the growth rates used in BERK's forecast. The growth rates assumed in the Macroeconomic Forecast for the same periods of time are provided for context. To develop 2040 control totals, BERK adopted the regional totals and county breakdowns in LUV 1.0 with slight adjustments to Kitsap and Pierce Counties.

Table 4-10: Comparison of Average Annual Employment Growth Rates

County	PSRC Total Emp. Est.	PSRC LUV 1.0 Forecast		BERK Forecast	
	2010 - 2014	2010 - 2025	2025 - 2040	2015 - 2020	2020 - 2040
King	2.85%	1.77%	1.34%	1.05%	1.28%
Kitsap	0.74%	1.29%	1.49%	0.70%	1.22%
Pierce	1.50%	1.30%	1.79%	0.65%	1.47%
Snohomish	3.35%	1.84%	1.74%	0.89%	1.45%
Total	2.61%	1.68%	1.48%	0.94%	1.33%
PSRC 2015 Macroeconomic Forecast	3.20%	1.68%	1.47%	0.94%	1.33%

Source: PSRC, 2015; BERK, 2016

Table 4-11 compares BERK's total employment forecast by county to PSRC[19].

Table 4-11: Total Employment Forecast Comparison

County	2020			2040		
	PSRC Macro.	BERK	% Diff.	PSRC LUV 1.0	BERK	% Diff.
King	1,463,676	1,463,676	0.0%	1,875,877	1,886,067	0.5%
Kitsap	112,202	107,621	-4.1%	147,352	137,257	-6.9%
Pierce	376,181	376,181	0.0%	503,388	503,293	0.0%
Snohomish	338,528	343,110	1.4%	457,274	457,274	0.0%
Total	2,290,587	2,290,588	0.0%	2,983,891	2,983,891	0.0%

Source: PSRC, 2015; BERK, 2016

Table 4-12 and **Table 4-13** show BERK forecasts breakdowns by county employment sector for 2020 and 2040.

Table 4-12: BERK 2020 Employment Projections

County	Construction/ Resource	Manufacturing/ WTU	Retail/Food Services	FIRE/Other Services	Government/ Higher Ed.	K-12	Military	Total
King	68,716	248,528	241,627	723,277	129,128	51,820	580	1,463,676
Kitsap	4,252	16,227	18,811	40,577	12,641	7,230	7,882	107,620
Pierce	23,167	48,474	63,688	140,138	42,446	22,022	36,247	376,182
Snohomish	22,925	77,792	65,622	129,566	24,171	18,323	4,711	343,110
Total	119,060	391,021	389,748	1,033,558	208,386	99,395	49,420	2,290,588

Source: BERK, 2016

[19] PSRC Regional Macroeconomic Forecast used for 2020 regional total. LUV 1.0 interpolated county totals used to calculate county and Seattle shares of regional total. 2040 PSRC based on LUV 1.0.

Table 4-13: BERK 2040 Employment Projections

County	Construction/ Resource	Manufacturing/ WTU	Retail/Food Services	FIRE/Other Services	Government/ Higher Ed.	K-12	Military	Total
King	80,268	281,645	321,252	1,020,751	121,225	60,346	580	1,886,067
Kitsap	3,836	17,690	25,991	60,419	12,872	8,568	7,882	137,258
Pierce	27,802	55,537	92,224	220,118	46,735	24,629	36,247	503,292
Snohomish	26,808	74,280	99,044	201,926	26,882	23,623	4,711	457,274
Total	138,714	429,152	538,511	1,503,214	207,714	117,166	49,420	2,983,891

Source: BERK, 2016

4.5.4 Subarea Forecast Review

LUV 1.0 includes suppressed sector and total employment data values for many census tracts. Review of these data included analysis to derive values for each instance of data suppression. This work built upon similar analysis for 2010 and 2015 and allocated employment consistent with countywide control totals. For tracts within the City of Seattle, BERK obtained 2015 Comprehensive Plan preferred alternative total employment growth targets by TAZ for the 2015 – 2035 period. BERK added these to the 2015 projections developed for this study to derive preliminary employment totals by tract. Relative shares of employment by sector and tract in the LUV 1.0 forecast were used to breakdown employment totals by sector for City of Seattle tracts.

Additional review was performed to determine consistency of the growth targets with recent permitting activity in the City of Seattle. **Figure 4-5** presents a map of Seattle's preferred alternative 2015 – 2035 employment growth targets with commercial, institutional, and industrial new construction permit applications from 2014 to March 2016. A portion of these permits includes information about the estimated value of the completed building. These permits are symbolized with graduated light blue circles. The remainder are symbolized with pink dots.

The size of the circle or number of permits does not necessarily correlate well with total employment growth expected to be accommodated in the new building. For example, many permits refer to mixed use projects with ground floor retail and residential above. Some institutional permits include student housing. Many permits involve the demolition of existing employment capacity. Therefore, a first step of this analysis was to identify clear mismatches between permit activity and expected growth. Four census tracts that were particularly notable in this regard are highlighted on the map.

Next BERK looked at the individual building permits to determine if they are indeed likely to result in additional capacity for employment within the tract. In such cases, minor adjustments were made to the total employment growth expected within those tracts. This map was used to inform the timing of employment growth within the City of Seattle. Tracts with significant projected employment growth and little permit activity were more likely to have the majority of their employment growth pushed to the 2020 – 2040 forecast period. Conversely, more short-term growth (2015 – 2020) was pushed to tracts with a greater amount of recent permit activity.

Figure 4-6 compares BERK's total employment forecast for summary districts 1-14 to LUV 1.0. Both forecasts show employment growing at a similar rate. The difference in total employment is explained by the fact that Seattle's employment growth targets build upon a higher baseline than is assumed in LUV 1.0. Also shown in this chart is the employment forecast assumed during preliminary analyses of the SR 99 study, for comparison.

Figure 4-5: City of Seattle Employment Growth Targets Compared to Recent Permit Activity

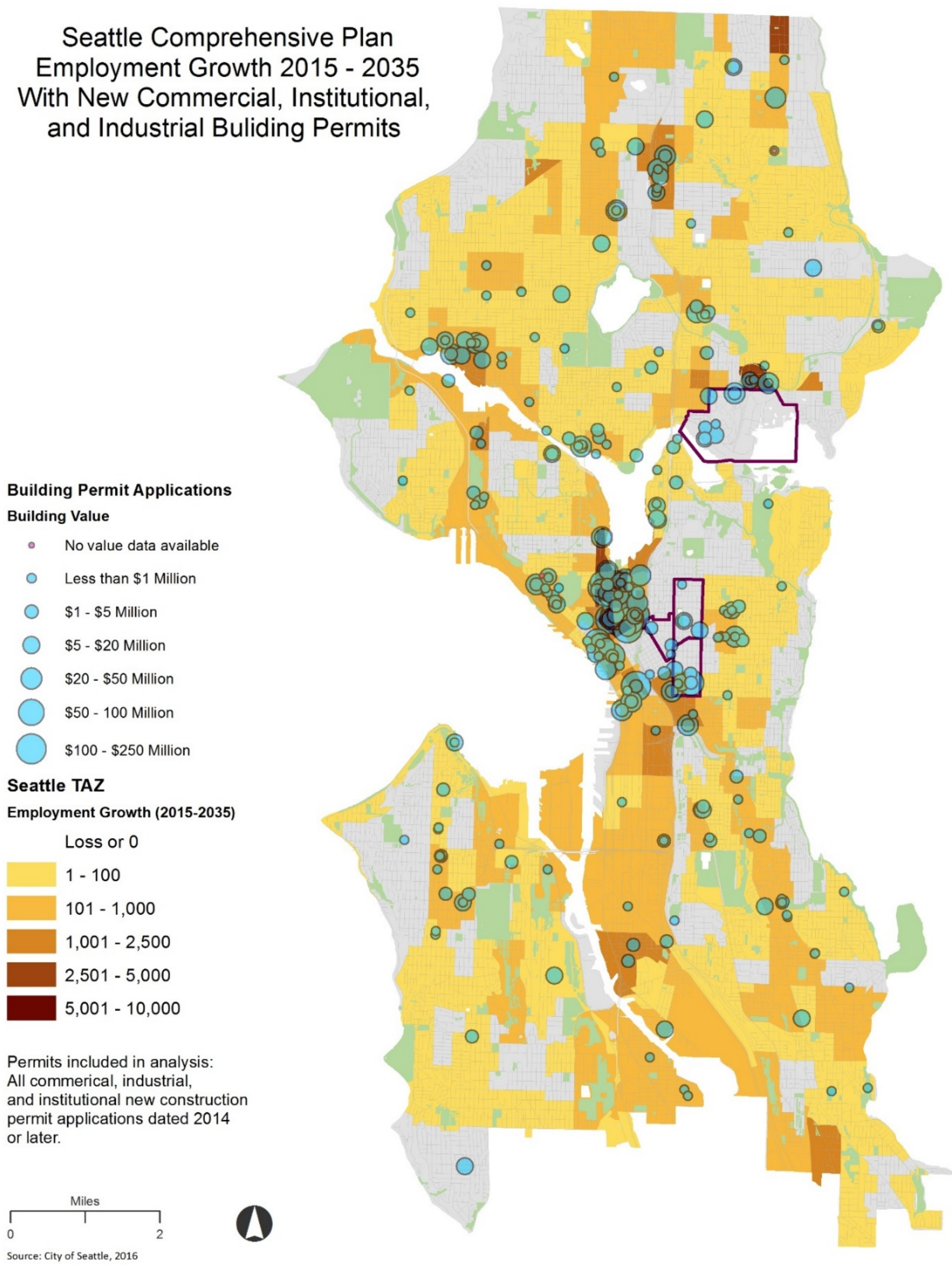
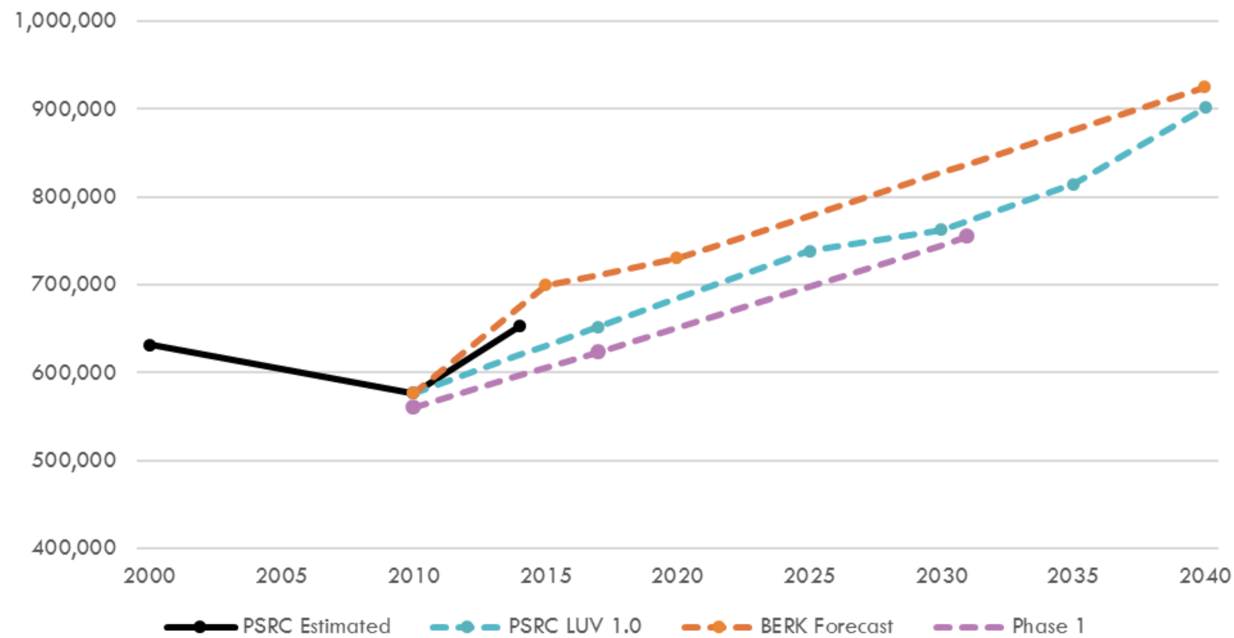


Figure 4-6: District 1-14 Employment Forecast Comparison



Source: PSRC, 2015; BERK, 2016

5.0 MODEL DEVELOPMENT AND CALIBRATION

5.1 OVERVIEW

The project team developed a two-tier travel-demand/traffic simulation model platform to perform the traffic and revenue forecast. A regional travel demand model (TDM), version 4k 4.03 developed by Puget Sound Regional Council (PSRC), and a Dynamic Traffic Assignment (DTA) model were utilized to complete the investment grade traffic and revenue modeling. A DTA model, inherited from the Alaskan Way Viaduct & Seawall Replacement Project (AWV project), was employed and underwent modifications for the study. Several components were significantly enhanced. A series of model enhancements were implemented, which include the followings:

- Implementation of logit-based toll diversion algorithm;
- Traffic analysis zone system to reflect regional TDM (PSRC 4K) zonal structure;
- Highway network refinement to support revised TAZ system, to reflect base year roadway connectivity and expanded network coverage; and
- Travel demand patterns reflective of 2015 base year condition and compatible with the DTA model from regional TDM

These models served as the basis for the traffic and revenue forecast. The base model calibration reflects 2015 traffic conditions, using contemporaneous traffic volume and origin-destination pattern data compiled for this effort as detailed in Chapter 3 of this report.

5.2 REGIONAL TRAVEL DEMAND MODEL

The purpose of the regional model is to provide the overall travel demand and base travel patterns for movements that traverse or influence the traffic that will use the roadways in the SR 99 study area, based on appropriate socioeconomic assumptions with relevant traffic analysis zone (TAZ) system and corresponding transportation networks (highway and public transit, respectively). The regional model's estimates should be sensitive to tolls and will provide estimates of the change in transit usage in response to the tolling of SR 99. The model was calibrated to the observed 2015 conditions. The calibration approach is discussed in further detail in the later sections of this chapter.

Post-processing primarily includes a subarea extraction process that was used to provide vehicular trip tables compatible for the DTA modeling effort. The subarea extraction process was modified to account for the additional roadways within the 4,000-zone model.

5.2.1 Model Input Assumptions

The project team adopted the latest PSRC 4K trip-based four-step travel demand model (version 4.03) that was made available at the beginning stage of the investment grade study in early 2015. It was anticipated that this 4,000-zone model will provide equivalent or superior granularity within and adjacent to the detailed study area.

A series of enhancements were implemented by PSRC to individual modules from the previous 1K version model, from trip generation to highway/transit assignment steps. The project team made additional refinements, as necessary, in the 2015 base year model calibration effort. The input assumptions will be discussed in the sections below, which include:

- Base Year Socioeconomic estimates
- Traffic Analysis Zones (TAZs) System
- Highway and Transit Networks
- Travel Demand

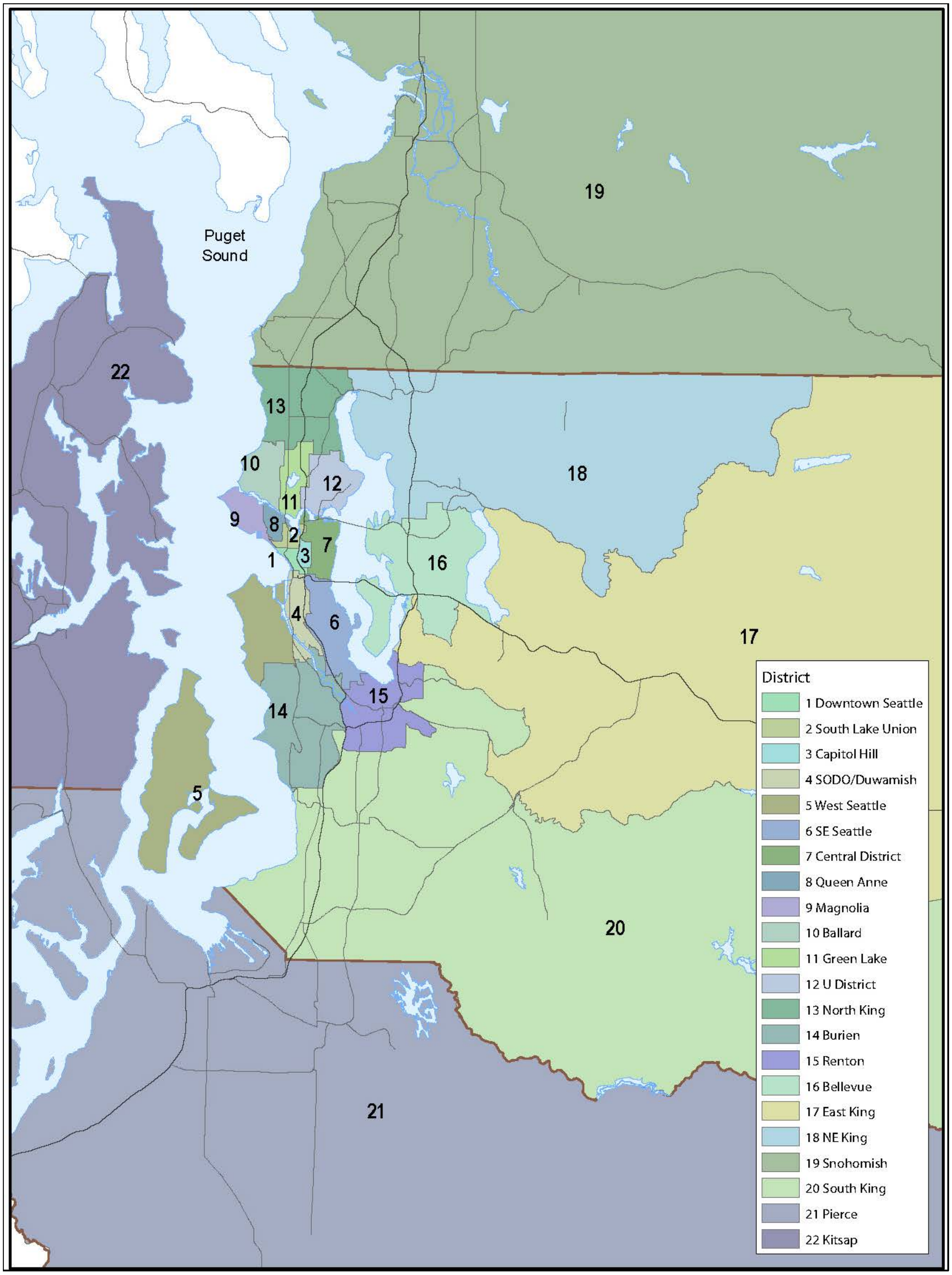
5.2.2 Base Year Socioeconomic Assumptions

The 2015 base year socio-economic data (SED) was estimated by BERK Consulting. The prior chapter of this report describes the corresponding background assumptions and methodology associated with the SED forecasting process. BERK conducted an independent review of available regional and subarea land use forecast products for Central Puget Sound region. The key sources include PSRC's 2015 Regional Macroeconomic Forecast, the Estimated Growth Capacity by Parcel, and Land Use Vision Forecast (LUV) version 1.0. Based on this review, necessary adjustments were then made to develop a revised forecast data product that is suitable to inform the development of investment grade quality traffic and revenue estimates. The 2015 SED estimates as the modeling input assumptions for the SR 99 Investment Grade T&R study is summarized in **Table 5-1** below at district and county level. The map of the district is provided in **Figure 5-1**.

Table 5-1: Summary of 2015 SED Input Assumptions

District	District Name	Residential		Employment					
		Total HH	Housing Unit	Retail - Food Services	FIRE - Services	Gov't/ Higher Educ	Education K-12	MFG + WTU	Total Emp
1	Downtown Seattle	20,592	23,386	29,208	107,762	15,114	277	9,526	161,887
2	South Lake Union	16,177	18,455	5,506	45,537	3,041	110	5,054	59,248
3	Capitol Hill	21,919	23,476	8,331	22,309	14,342	125	501	45,607
4	SODO/Duwamish	3,576	3,784	7,479	21,891	9,405	253	23,918	62,945
5	West Seattle	44,832	47,854	6,270	13,711	2,065	1,959	5,369	29,374
6	SE Seattle	33,517	34,845	3,998	12,117	4,367	1,900	12,951	35,334
7	Central District	28,162	29,490	4,095	18,572	792	1,621	1,331	26,412
8	Queen Anne	14,061	14,799	2,475	7,231	1,422	361	1,698	13,187
9	Magnolia	11,233	11,682	1,525	4,779	494	162	3,492	10,452
10	Ballard	33,684	35,072	7,377	13,265	801	995	3,888	26,326
11	Green Lake	32,492	33,976	9,378	22,684	2,275	960	2,387	37,683
12	U District	33,718	35,415	9,039	17,877	27,714	1,460	922	57,013
13	North King	53,362	55,741	8,326	20,186	4,279	3,449	1,379	37,620
14	Burien	42,969	45,980	9,846	27,510	4,797	3,025	19,350	64,527
15	Renton	31,818	34,076	16,904	28,296	6,679	1,561	28,178	81,618
16	Bellevue	68,063	72,659	28,031	136,847	6,481	6,543	16,578	194,481
17	East King	62,123	66,127	11,319	29,204	2,501	4,576	6,439	54,039
18	NE King	101,366	107,323	21,800	67,940	9,122	6,430	21,233	126,524
19	Snohomish	282,466	300,724	59,585	117,002	21,608	16,539	84,052	298,786
20	South King	188,057	199,183	38,248	69,682	12,238	13,782	57,485	191,435
21	Pierce	311,060	337,888	62,283	131,293	40,045	21,611	47,942	303,174
22	Kitsap	99,085	109,864	18,434	37,749	11,292	6,607	16,463	90,545
King		841,721	893,324	229,154	687,401	127,930	49,550	221,676	1,315,711
Kitsap		99,085	109,864	18,434	37,749	11,292	6,607	16,463	90,545
Pierce		311,060	337,888	62,283	131,293	40,045	21,611	47,942	303,174
Snohomish		282,466	300,724	59,585	117,002	21,608	16,539	84,052	298,786
4-County Total		**1,534,332**	**1,641,800**	**369,457**	**973,446**	**200,874**	**94,307**	**370,133**	**2,008,217**

Figure 5-1: Land Use District Map



5.2.3 Traffic Analysis Zones System

The model coverage consists of the four-county Puget Sound region, including King, Snohomish, Kitsap, and Pierce counties, centering on the City of Seattle. The model has a total of 3,700 internal and 18 external TAZs, in addition to 150 Park-and-Ride (PNR) zones, with corresponding highway and transit network details to support the zonal system.

5.2.4 Highway and Transit Networks

The detailed highway network from the PSRC 4K model was utilized as the basis for this study. Since the model's base year networks reflect 2010 conditions, it was necessary to perform appropriate updates to reflect the 2015 base year configuration. This updating process was focused on the DTA model subarea, including the realignment of SR 99, the impacted area in the northern and southern ends of the future tolled tunnel as well as other notable/ significant highway improvement projects. The following projects were incorporated into the 2015 base year model accordingly:

- The interim SR 99 alignment and configuration between Mercer and S. Massachusetts Streets;
- The construction-related Mercer Street and S. Massachusetts St area configuration;
- Recent roadway/connectivity improvements on the Spokane Street Viaduct/West Seattle Bridge corridor;
- The introduction of tolling on SR 520.

Note that, the I-405 express toll lanes between Northeast 6th Street in Bellevue and I-5 in Lynnwood that was opened in September 2015 was not considered in the base year model which reflect early 2015 traffic conditions. This project was coded in the future year 2020 model.

For transit, enhancements to the network involved primarily the restructuring of King County Metro bus routes pertinent to the Rapid Ride Lines and corresponding changes to other bus services, as well as the updating of existing transit line routing to maintain consistency with the revised highway network.

5.2.5 Travel Demand

In the PSRC trip-based demand modeling process, daily person trips are estimated from the SED variables (including the number of households and jobs by employment type) pertinent to the internal TAZs within the Puget Sound region, based on a set of pre-defined trip production and attraction relationships, in additional to the trips specified for the 18 external stations in the model. A total of 7 trip purposes are maintained in the modeling process, from trip generation to mode choice with further stratification by four Income levels, where applicable:

- Home-Based Work (HBW)
- Home-Based College (COL)
- Home-Based School (SCH)
- Home-Based Shop (HBS)
- Home-Based Other (HBO)
- Non-Home-Based Work (WBO)
- Non-Home-Based Other (OBO)

In addition to household resident trips, commercial vehicles (or trucks), are also considered in the PSRC model, respectively for light, medium and heavy classes. Truck trips are generated for

individual TAZ and specified for each external station from SED attributes (primarily zonal employment).

The mode choice modeling process apportions each person trip matrix by purpose to the available travel modes at a daily level after the trip distribution step. The available mode choice options are specified as below:

- Drive alone (SOV)—Single-occupancy auto trips
- Shared ride 2 (HOV2)—Auto trips with two occupants
- Shared ride 3+ (HOV3+)—Auto trips with three or more occupants
- Transit – Walk access
- Transit - Drive access
- Walk
- Bicycle

A time-of-day choice modeling process then respectively stratifies the household resident and commercial vehicle trips using pre-defined survey-based factors or, where applicable, probabilistic functions which consider the time period specific congested highway travel time to stratify daily trips into different time periods. A total of five time periods are maintained in the PSRC trip-based model, including AM (6am to 9am), MD (9am to 3pm), PM (3pm to 6pm), EV (6pm to 1pm), and NI (10pm to 6am). A subsequent modeling step will then prepare the corresponding input trip matrices for traffic assignment purposes. For auto/highway vehicle assignment, person trips are converted to vehicles with appropriate occupancy factors for HOV2 and HOV3+ trips. The highway assignment considers a total of 11 vehicle classes as listed below:

- SOV (HBW Income 1)
- SOV (HBW Income 2)
- SOV (HBW Income 3)
- SOV (HBW Income 4)
- SOV (all other purposes)
- HOV2 (all purposes)
- HOV3+ (all purposes)
- Vanpool vehicles
- Light Truck
- Medium Truck
- Heavy Truck

5.3 MODEL VALIDATION DATA

A set of observed traffic data was compiled and used to establish model calibration targets, including:

- PSRC 2014 Household Travel Survey (HTS) data;
- American Community Survey (ACS) 2006-2009 Journey to work data;
- Recent traffic volume data collected by the project team (ATR and TMC) and from WSDOT traffic count databases;
- 2014 observed transit boarding aggregated summary (Sound Transit and King County); Bus boarding and alighting by routes.

PSRC provided a detailed HTS dataset which was used to compute daily person trip production rates by purpose, average trip length, production/attraction flow patterns, mode shares, and

time-of-day temporal profile for the Puget Sound region. Prior to processing, appropriate expansion factors were applied to each survey record to reflect total population size.

The project team conducted a traffic data collection program (detailed in a prior chapter of this report) throughout the SR 99 study area in early 2015 and were provided with additional traffic counts from WSDOT at selected permanent traffic reporter (PTR) and Northwest Region Ramp and Roadway data stations. Highway traffic volume data were organized along screenlines developed specifically for the SR 99 Toll Tunnel project corridor by corresponding model time period, primarily provided as model validation of data for highway traffic assignment and secondarily for time-of-day and trip distribution models.

5.4 MODEL CALIBRATION AND VALIDATION

The regional model calibration effort was primarily focused on matching the observed recent travel conditions depicted by the household survey data (including trip generation rates, O-D patterns, mode shares and temporal profiles) as summarized in the above sections. The parameters of the regional model's trip generation, distribution, and mode choice were modified accordingly to facilitate this objective.

The model calibration effort also aimed to replicate 2015 weekday traffic and travel times and speeds on the major roadways in the project corridors, where the validity of parameters associated with the volume-delay function (VDF) would be examined.

5.4.1 Trip Generation

Observed trip production rates by purpose were derived using PSRC HTS data. Modifications to these observed rates were performed in consideration to the GPS adjustment performed for the 2006 travel survey accounting for under reporting. These values were adopted as targets for model calibration. Stantec consulted PSRC for 2014 level of adjustments, which according to PSRC was approximately 5 to 10 percent. Modeled trip rates were adjusted to match targets, as summarized in **Table 5-2** below.

At the time of the SR 99 2015 model calibration effort, the adjustments for the 2014 were not yet available. During the calibration analysis Stantec had email conversations with PSRC staff in September 2015, at which time PSRC had expectations that the final adjusted rates for the 2014 survey could possibly be 5-10 percent higher than the initial values. Given that range and the 17 percent under-reporting from the PSRC 2006 survey, Stantec selected 10 percent as the under-reporting adjustment rate. The use of the 10 percent value assumed that the more recent survey would have a better capture of total trip making but would not achieve the more aggressive level of underreporting being as low as 5 percent. The 10 percent rate was applied equally to all purposes. As listed in **Table 5-2**, the observed target per person per day trip rate is established as 4.12 trips, approximately 6 percent lower than the 4.41 trips equivalent from the 2006 survey.

Table 5-2: Trip Production Factoring for Unreported Travel

Trip Purpose	Production Rates / Person					
	2006 Survey			2014 Survey		
				Initial	Stantec 2015 Calibration	
	Initial	Adjusted	% change		Adjusted	% change
Home-Based Work	0.62	0.66	6%	0.62	0.68	10%
Home-Based College	0.04	0.04	7%	0.05	0.05	10%
Home-Based School	0.31	0.33	8%	0.25	0.28	10%
Home-Based Shopping	0.31	0.36	17%	0.39	0.43	10%
Home-Based Other	1.37	1.60	17%	1.33	1.46	10%
Non-Home-Based Work	0.38	0.47	24%	0.43	0.47	10%
Non-Home-Based Other	0.73	0.95	29%	0.68	0.75	10%
Total	3.76	4.41	17%	3.75	4.12	10%

In **Table 5-3** below, the resulting trip production rates from the PSRC 4K model are compared with the observed targets. Overall, the PSRC default model prediction is significantly higher than the observed values by 10 percent, with an overall total of 17,337,900 daily person trip produced for the model study area. Using adjustment factors by trip purpose, derived as part of our review of recent survey data, resulted in a final estimate of 15,661,100 daily person trips.

Table 5-3: Comparison of Regional Model Trip Production Rates and Daily Person Trips

Trip Purpose	Trip Production Rate Assumptions				Daily Person Trips	
	Observed		2015 Model Estimates		2015 Model Estimates	
	HTS (2014)	Adjusted	Initial	Final	Initial	Final
Home-Based College	0.05	0.05	0.06	0.06	168,600	142,900
Home-Based Other	1.33	1.46	1.65	1.46	6,297,500	5,560,400
Home-Based Shop	0.39	0.43	0.38	0.43	1,434,800	1,644,600
Home-Based School	0.25	0.28	0.36	0.28	1,366,100	1,054,000
Non-Home-Based Other	0.68	0.75	0.91	0.75	3,454,200	2,871,400
Non-Home-Based Work	0.43	0.47	0.49	0.47	1,866,000	1,806,300
Home-Based Work	0.62	0.68	0.72	0.68	2,750,700	2,581,500
Total Person Trips	3.75	4.12	4.56	4.12	17,337,900	15,661,100

5.4.2 Trip Distribution

The trip distribution models estimate the number of trips traveling between individual TAZs using the gravity model. The first step in trip distribution model calibration was to evaluate the reasonableness of the average trip length from the model estimates against the observed targets. Average trip length (distance in miles) from the expanded 2014 HTS data was tabulated for each trip purpose as a model calibration target and was compared with the 2006 equivalent. As summarized in **Table 5-4**, except for the HBW trip purpose, average travel

distance in 2014 decreased slightly from the 2006 values, implying changes in travel behavior in the Puget Sound region. Assuming that the default PSRC model adopted the higher calibration targets with 2006 survey data, the initial model estimates are also higher than the 2014 observations. In this case, it would be necessary to refine the gravity model parameters to match the observed 2014 level. As PSRC eliminated the gamma parameters in the friction factor formulation for all trip purposes, the adjustments were therefore limited to the beta terms. The final model estimates after the adjustments as shown in **Table 5-4** compared well against the observed targets.

Table 5-4: Comparison of Regional Model Trip End and Average Trip Length by Purpose

Trip Purpose	Observed (PSRC HTS)		2015 Base Year Model Estimates	
	2006	2014	Initial	Final
Home-Based College	8.1	7.8	7.4	7.4
Home-Based Other	5.5	4.8	5.6	4.6
Home-Based Shop	4.6	4.0	4.6	3.9
Home-Based School	4.4	3.4	3.4	3.2
Non-Home-Based Other	4.6	4.4	4.6	4.2
Non-Home-Based Work	6.2	6.7	7.4	6.2
Home-Based Work	11.4	11.7	12.5	11.3
Total Trips	6.2	5.9	6.5	5.7

In addition to average trip length, the observed daily person trip distribution patterns were also tabulated at a district level from the 2014 HTS data to facilitate the assessment of model estimates. The ACS Journey-to-Work data reflecting years 2006 to 2009 were also summarized as an alternative observed dataset for home-to-work commute patterns. The map representing this district system is shown in **Figure 5-2**, generally corresponding to individual counties with the exception of King County which was divided into the districts of Downtown, Other DTA subarea (i.e. excluding Downtown/the CBD), and Other King.

For the HBW trip purpose the observed patterns are as shown in **Table 5-5** and **Table 5-6**, respectively, for the two available sources. It is observed that the initial model estimates from the default PSRC model (**Table 5-7**) generally distributes higher level of trips to the DTA model subarea external to the downtown Seattle in comparison to the observed. The same comparison was performed for all other purposes combined. The observed pattern computed from 2014 HTS summarized in **Table 5-8** can be compared with the initial model estimates which also show bias towards the DTA subarea outside of downtown. **Table 5-9**, **Table 5-10**, and **Table 5-11** present similar information for non-HBW (Other) observed patterns.

As a common travel demand modeling practice, K-factors were incorporated into the regional TDM as a model refinement which aimed to improve the estimated travel demand patterns. Two different sets of K-factor matrices were calibrated and applied to trip distribution models for corresponding trip purposes. While this adjustment process has positively impacted the model estimates in terms of travel patterns, the results from the downstream highway traffic assignment showed that the highway traffic traversing the crossings along the Ship Canal and Lake Washington are significantly higher than the observed volume, indicating that the estimated travel between the City of Seattle core area and surrounding areas are possibly too high. To suppress cross-canal/lake travel, an additional refinement to the trip distribution model was

introduced by incorporating a set time penalties between 0.5 to 5.0 mins for the corresponding movements.

Figure 5-2: Map of Trip Distribution Summary District

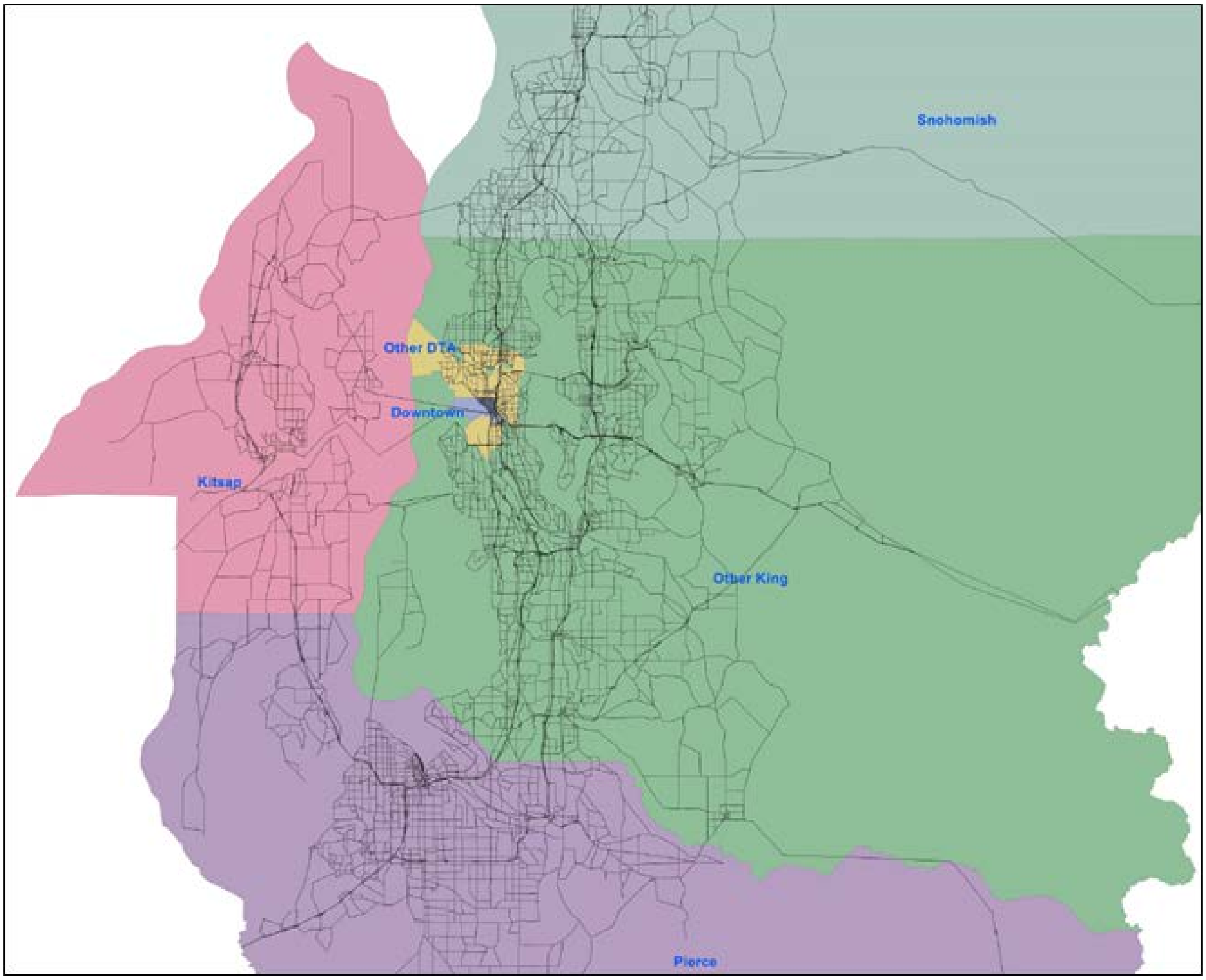


Table 5-5: PSRC 2014 HTS Daily Person Trip Distribution as % of Origin (HBW)

	Downtown	Other DTA	Other King	Snohomish	Pierce	Kitsap	Total
Downtown	45.9%	26.6%	25.1%	0.3%	1.0%	1.1%	100.0%
Other DTA	20.4%	41.8%	34.2%	3.2%	0.2%	0.2%	100.0%
Other King	12.3%	14.4%	66.9%	3.5%	2.7%	0.2%	100.0%
Snohomish	6.2%	6.2%	27.7%	59.8%	0.2%	0.0%	100.0%
Pierce	4.2%	1.4%	24.5%	1.0%	68.1%	0.8%	100.0%
Kitsap	7.0%	5.0%	2.6%	0.0%	9.7%	75.8%	100.0%
Total	10.0%	11.7%	44.7%	13.5%	15.6%	4.4%	100.0%

Table 5-6: ACS 2006-9 Daily Person Trip Distribution as % of Origin (HBW)

	Downtown	Other DTA	Other King	Snohomish	Pierce	Kitsap	Total
Downtown	37.2%	25.5%	33.5%	2.3%	1.1%	0.3%	100.0%
Other DTA	21.7%	41.2%	33.4%	2.8%	0.7%	0.2%	100.0%
Other King	9.4%	15.6%	67.6%	4.1%	3.1%	0.2%	100.0%
Snohomish	4.3%	7.0%	24.9%	63.0%	0.5%	0.2%	100.0%
Pierce	1.6%	2.4%	21.3%	0.5%	73.1%	1.2%	100.0%
Kitsap	4.0%	3.4%	4.2%	1.2%	5.6%	81.6%	100.0%
Total	7.6%	12.5%	43.4%	14.3%	16.6%	5.5%	100.0%

Table 5-7: Initial Model Estimated Daily Person Trip Distribution as % of Origin (HBW)

	Downtown	Other DTA	Other King	Snohomish	Pierce	Kitsap	Total
Downtown	28.8%	42.1%	27.6%	1.3%	0.2%	0.0%	100.0%
Other DTA	20.7%	48.1%	29.1%	1.9%	0.2%	0.0%	100.0%
Other King	8.9%	17.4%	66.9%	4.1%	2.7%	0.0%	100.0%
Snohomish	3.4%	7.8%	28.7%	60.0%	0.1%	0.0%	100.0%
Pierce	2.2%	3.5%	31.5%	0.2%	61.2%	1.3%	100.0%
Kitsap	2.5%	3.5%	6.9%	1.2%	14.4%	71.5%	100.0%
Total	7.1%	14.3%	46.2%	13.9%	14.0%	4.4%	100.0%

Table 5-8: Final Model Estimated Daily Person Trip Distribution as % of Origin (HBW)

	Downtown	Other DTA	Other King	Snohomish	Pierce	Kitsap	Total
Downtown	53.6%	21.4%	24.0%	0.8%	0.1%	0.0%	100.0%
Other DTA	25.9%	42.0%	30.5%	1.4%	0.1%	0.0%	100.0%
Other King	12.2%	13.2%	69.2%	3.1%	2.2%	0.0%	100.0%
Snohomish	2.5%	8.2%	26.0%	63.3%	0.0%	0.0%	100.0%
Pierce	1.3%	3.2%	26.9%	0.1%	67.4%	1.1%	100.0%
Kitsap	1.3%	2.6%	3.8%	0.8%	13.1%	78.3%	100.0%
Total	9.0%	11.8%	46.2%	14.1%	14.5%	4.4%	100.0%

Table 5-9: PSRC 2014 HTS Daily Person Trip Distribution as % of Origin (Other)

	Downtown	Other DTA	Other King	Snohomish	Pierce	Kitsap	Total
Downtown	57.8%	16.6%	21.3%	2.5%	0.5%	1.4%	100.0%
Other DTA	7.5%	66.5%	23.5%	2.0%	0.5%	0.0%	100.0%
Other King	2.1%	5.2%	88.5%	2.1%	2.0%	0.1%	100.0%
Snohomish	0.5%	1.4%	9.2%	88.8%	0.1%	0.0%	100.0%
Pierce	0.2%	0.4%	5.5%	0.1%	93.4%	0.5%	100.0%
Kitsap	0.3%	0.4%	0.6%	0.0%	2.5%	96.2%	100.0%
Total	3.0%	7.6%	45.6%	17.2%	20.1%	6.5%	100.0%

Table 5-10: Initial Model Estimated Daily Person Trip Distribution as % of Origin (Other)

	Downtown	Other DTA	Other King	Snohomish	Pierce	Kitsap	Total
Downtown	28.8%	45.3%	24.8%	1.0%	0.1%	0.0%	100.0%
Other DTA	13.0%	62.2%	24.0%	0.8%	0.1%	0.0%	100.0%
Other King	2.7%	8.9%	84.3%	2.3%	1.7%	0.0%	100.0%
Snohomish	0.3%	1.5%	13.0%	85.2%	0.0%	0.0%	100.0%
Pierce	0.0%	0.1%	7.4%	0.0%	91.6%	0.9%	100.0%
Kitsap	0.0%	0.0%	0.0%	0.0%	2.6%	97.3%	100.0%
Total	3.1%	11.1%	45.8%	16.1%	18.2%	5.7%	100.0%

Table 5-11: Final Model Estimated Daily Person Trip Distribution as % of Origin (Other)

	Downtown	Other DTA	Other King	Snohomish	Pierce	Kitsap	Total
Downtown	57.4%	25.0%	17.1%	0.4%	0.1%	0.0%	100.0%
Other DTA	14.3%	63.3%	21.9%	0.5%	0.0%	0.0%	100.0%
Other King	3.1%	7.6%	85.9%	2.0%	1.4%	0.0%	100.0%
Snohomish	0.1%	1.1%	10.3%	88.4%	0.0%	0.0%	100.0%
Pierce	0.0%	0.0%	5.1%	0.0%	94.1%	0.7%	100.0%
Kitsap	0.0%	0.0%	0.0%	0.0%	1.8%	98.2%	100.0%
Total	4.0%	9.0%	45.7%	16.7%	18.7%	5.8%	100.0%

The project team also revised the default approach used in the PSRC 4K model for special generation estimates of airport-passenger related person trips, where the total numbers of daily person trips was derived from default model input parameters and are split into HBO trips and WBO trips at 75% and 25%, respectively. The balanced productions and attractions were then incorporated into the PSRC trip distribution modules.

A prior analysis shows the median travel distance to the Seattle Tacoma International Airport of about 18.5 miles, compared to the average trip length of approximately 8 miles for HBO trips estimated from the default PSRC model. Using the existing PSRC approach, the trips to and from the airport will be much shorter than observed data indicates.

The revised approach utilized relationships from survey-based airport trip models established for northern New Jersey and central North Carolina (which was adopted from the Minneapolis region). The base relationships were scaled such that total airport trip generation matches the PSRC 2010 control total airport trips related to flights for the special generator zone, excluding normal work trips associated with employment in that zone. The airport trips between each zone and the airport zone is defined using the following formula:

- Airport Trip Ends HBO (production zone) = 0.02112 * population
- Airport Trip Ends WBO (production zone) = 0.01486 * employment

This revised process required that the airport special generator trip attractions used as input to the model be set equal to zero. The trips from each production zone are computed by purpose and specified in respective text files as model input trip ends (which serves as the attraction trip end). An EMME macro script embedding a matrix addition process would then incorporate the airport trips with any existing trips by purpose that are generated from the employment in the airport zone.

The weighted average trip length for HBO and WBO special generator trips was calculated to be 26.5 miles (+/- 14 miles) from the revised approach, which is considered to be a more logical trip pattern than the PSRC methodology.

5.4.3 Mode Choice

As shown in **Table 5-12** and **Table 5-13**, the initial model estimates compared well against the observed for HBW trip purpose at the regional level and in the downtown area. However, for non-work trip purposes, the transit mode was understated in general for the region and downtown Seattle area. A comparison in ridership between observed and model estimates (**Table 5-22** later in this chapter) indicates that public transit usage in the off-peak period (MD 9am to 3pm) was significantly understated. To rectify this shortfall, the mode bias constants to Home-Based Shop/Other and Non-Home Based trips were modified to increase off-peak period transit mode shares to better match observed transit boarding. Note that after the adjustments to the mode choice model, the estimated mode shares are in-line at a regional level, but are still significantly low in the downtown Seattle area. While it is important to realistically model mode shares in the CBD area, further adjustments to the mode choice targeting this area would negatively impact the observed regional fit.

Table 5-12: Comparison of Person Trips by Mode Attracted to All-Destination

Mode	Home-Based Work				Other Purposes		
	Observed		2015 Base Year Model Estimates		Observed	2015 Base Year Model Estimates	
	ACS JTW (2006-9)	HTS (2014)	Initial	Final	HTS (2014)	Initial	Final
SOV	74%	71%	74%	74%	37%	37%	36%
HOV (2+)	12%	9%	8%	8%	42%	50%	48%
Transit	9%	13%	11%	11%	3%	2%	3%
Walk and Bike	6%	7%	7%	7%	18%	11%	13%
Total	100%	100%	100%	100%	100%	100%	100%

Table 5-13: Comparison of Person Trips by Mode Attracted to Downtown Seattle

Mode	Home-Based Work				Other Purposes		
	Observed		2015 Base Year Model Estimates		Observed (Distance > 0.75 mi)	2015 Base Year Model Estimates	
	ACS JTW (2006-9)	HTS (2014)	Initial	Final	HTS (2014)	Initial	Final
SOV	38%	26%	22%	26%	20%	24%	21%
HOV (2+)	11%	7%	8%	8%	36%	49%	42%
Transit	41%	55%	48%	43%	32%	4%	5%
Walk and Bike	9%	12%	22%	23%	12%	23%	32%
Total	100%	100%	100%	100%	100%	100%	100%

5.4.4 Time-of-Day

The temporal profiles of travel by mode were tabulated from 2014 HTS data as observed model calibration targets to examine the reasonableness of model estimates, as summarized in **Table 5-14**. In general, the initial estimates from the default PSRC model reflect the observed values. However, some prominent discrepancies are observed for private autos (SOV and HOVs) and public transit modes. The time of day model parameters embedded in the model scripts were adjusted accordingly, specifically shifting traffic from evening period (6pm to 10pm) to the morning peak period (6am to 9am), and the shifting of transit trips from mid-day (9am to 3pm) to achieve a better fit to observed data.

Table 5-14: Comparison of Time of Day Person Trips by Mode

Time Period	Observed (2014 HTS)				2015 Base Year Model Estimates							
					Initial				Final			
	SOV	HOV (2+)	Transit	Walk/Bike	SOV	HOV (2+)	Transit	Walk/Bike	SOV	HOV (2+)	Transit	Walk/Bike
AM	17.8%	16.2%	24.4%	13.1%	15.2%	10.7%	30.6%	16.7%	19.4%	14.9%	23.3%	15.7%
MD	36.1%	32.5%	29.9%	38.4%	39.0%	36.5%	26.2%	38.8%	38.6%	33.0%	33.6%	39.0%
PM	25.5%	28.0%	28.8%	24.5%	21.0%	24.3%	28.7%	25.9%	20.6%	24.7%	28.2%	25.7%
EV	15.4%	21.2%	11.4%	21.1%	18.2%	24.9%	8.2%	16.7%	15.0%	22.5%	8.9%	17.6%
NI	5.2%	2.1%	5.5%	2.8%	6.6%	3.6%	6.3%	1.9%	6.5%	4.8%	6.0%	2.0%
Daily	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

5.4.5 Highway Traffic Assignment

As one of the performance measures of the regional model, vehicle-miles-traveled (VMT) were computed for a selected set of highway network links (mostly major highways in the region as well as arterial roadways in the DTA subarea) with corresponding traffic count data to examine whether the level of traffic from the models was reflective of observed conditions. The comparison as shown in **Table 5-15** indicated that the overall magnitude of traffic is within reasonable range of the observed.

Table 5-15: VMT Summary by Time Period

	AM	MD	PM	EV	NI
Observed	673,423	1,406,955	850,587	708,277	514,794
Estimated	679,795	1,287,639	812,900	624,139	511,675
Est/Obs	1.01	0.92	0.96	0.88	0.99

To more closely examine traffic levels and flow patterns within the DTA subarea, which encompasses the SR 99 project corridor and its competing/feeder roadways, several screenlines were constructed to monitor the inflow and outflow of traffic traversing the study area. A map showing the screenline locations is provided in **Figure 5-3**. At the daily level, as shown in **Table 5-16**, all screenlines are within 5 percent of actual counts except for the two screenlines at the Ship Canal in the northbound and North of Spokane St in the southbound direction, where both are within a 10 percent difference. The screenline traffic volumes for individual time periods were also compared between the observed and estimated, which include AM, MD and PM (as shown respectively from **Table 5-17**, **Table 5-18**, and **Table 5-19**) where most traffic generating land-use activities occur. While the model estimates are again generally within 5 percent tolerance of the observed for individual screenlines, a higher level of variance is observed at some lower/off-peak traffic locations. This variation may also be attributed by day-to-day variation of traffic profiles within the study area.

Figure 5-3: SR 99 Regional Model Screenline Locations

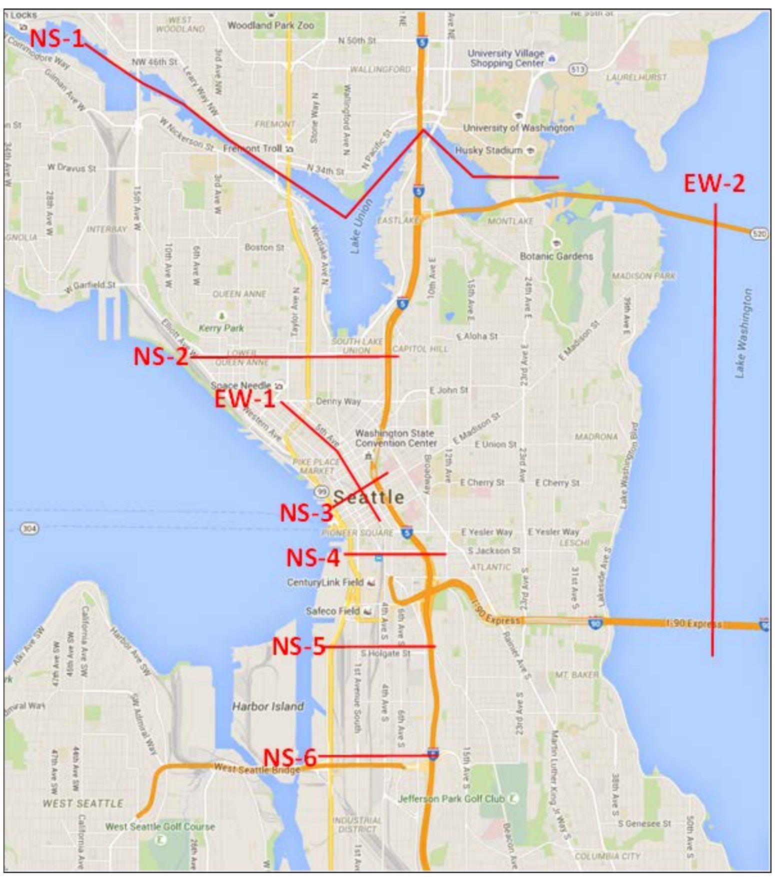


Table 5-16: Daily Screenline Summary

Screeline Code	Screenline Name	Daily					
		NB/EB			SB/WB		
		Obs	Est	% Diff	Obs	Est	% Diff
NS-1	Ship Canal	260,412	244,947	-5.9%	248,734	246,419	-0.9%
NS-2	South of Mercer St	233,413	230,399	-1.3%	205,092	204,999	0.0%
NS-3	North of Seneca St	217,867	217,350	-0.2%	210,633	214,908	2.0%
NS-4	South of S Jackson St	213,074	207,419	-2.7%	220,027	216,790	-1.5%
NS-5	South of S Massachusetts St	199,728	194,180	-2.8%	197,475	187,191	-5.2%
NS-6	North of Spokane St	170,986	173,055	1.2%	174,417	160,212	-8.1%
EW-1	East of 3rd Ave	50,437	51,818	2.7%	55,222	52,474	-5.0%
EW-2	Lake Washington	118,219	123,718	4.7%	118,924	120,998	1.7%

Table 5-17: AM Peak Period (6 to 9am) Screenline Summary

Screeline Code	Screenline Name	AM Period (6:00 to 9:00)					
		NB/EB			SB/WB		
		Obs	Est	% Diff	Obs	Est	% Diff
NS-1	Ship Canal	34,347	37,731	9.9%	60,499	57,487	-5.0%
NS-2	South of Mercer St	34,829	32,224	-7.5%	47,390	46,672	-1.5%
NS-3	North of Seneca St	39,576	41,223	4.2%	41,960	37,337	-11.0%
NS-4	South of S Jackson St	42,855	42,827	-0.1%	37,527	34,463	-8.2%
NS-5	South of S Massachusetts St	39,090	41,021	4.9%	33,191	29,208	-12.0%
NS-6	North of Spokane St	38,157	39,290	3.0%	27,194	23,295	-14.3%
EW-1	East of 3rd Ave	7,081	8,233	16.3%	10,143	9,863	-2.8%
EW-2	Lake Washington	22,863	22,737	-0.6%	26,454	27,262	3.1%

Table 5-18: MD Peak Period (9am to 3pm) Screenline Summary

Screeline Code	Screenline Name	Mid-Day Period (9:00 to 3:00)					
		NB/EB			SB/WB		
		Obs	Est	% Diff	Obs	Est	% Diff
NS-1	Ship Canal	85,025	80,343	-5.5%	84,653	83,808	-1.0%
NS-2	South of Mercer St	77,083	80,992	5.1%	70,080	72,998	4.2%
NS-3	North of Seneca St	71,943	75,155	4.5%	71,130	73,430	3.2%
NS-4	South of S Jackson St	74,069	67,973	-8.2%	72,332	74,433	2.9%
NS-5	South of S Massachusetts St	70,007	66,083	-5.6%	64,353	62,493	-2.9%
NS-6	North of Spokane St	59,095	59,393	0.5%	59,240	52,924	-10.7%
EW-1	East of 3rd Ave	16,738	19,674	17.5%	19,789	19,322	-2.4%
EW-2	Lake Washington	40,281	38,142	-5.3%	38,523	38,936	1.1%

Table 5-19: PM Peak Period (3 to 6pm) Screenline Summary

Screeline Code	Screenline Name	PM Period (3:00 to 6:00)					
		NB/EB			SB/WB		
		Obs	Est	% Diff	Obs	Est	% Diff
NS-1	Ship Canal	65,475	60,870	-7.0%	42,196	46,478	10.1%
NS-2	South of Mercer St	50,282	55,025	9.4%	35,400	38,153	7.8%
NS-3	North of Seneca St	46,348	43,776	-5.5%	39,245	45,966	17.1%
NS-4	South of S Jackson St	40,803	39,858	-2.3%	46,038	46,327	0.6%
NS-5	South of S Massachusetts St	38,615	36,874	-4.5%	42,902	41,843	-2.5%
NS-6	North of Spokane St	30,849	31,393	1.8%	39,845	37,272	-6.5%
EW-1	East of 3rd Ave	11,663	12,261	5.1%	10,729	11,485	7.0%
EW-2	Lake Washington	26,545	29,735	12.0%	24,623	25,334	2.9%

In addition to the assigned traffic volumes, the reasonableness of the model estimated travel time along the major roadway facilities including SR 99 and I-5 was also examined. The continuous travel time routes for both highway facilities started from N 45th Street to the north to S Spokane Street to the south, covering a total distance of 6.4 miles. Also included is the arterial route of 1st Avenue between Battery Street in downtown to the north and S Spokane Street to the south. As summarized in **Table 5-20** and **Table 5-21**, the observed traffic speed was computed from manual travel runs and compared to the model estimates. Overall, this comparison indicates that the speed-flow relationships are reasonable and therefore no adjustments to the model VDF parameters were performed in the regional model calibration process.

Table 5-20: AM Peak Period Travel Time Comparison

		SR 99		I-5		1st Ave	
		NB	SB	NB	SB	NB	SB
Distance (miles)		6.4		6.4		3.2	
Estimated Travel Time (mins)		16.7	12.6	12.2	9.6	16.3	15.1
Speed (mph)	Estimated	23.0	30.5	31.5	40.0	11.8	12.7
	Observed	32.7	26.4	33.1	25.5	11.3	11.8
	Difference	*-9.7*	*4.1*	*-1.6*	*14.5*	*0.5*	*0.9*

Table 5-21: PM Peak Period Travel Time Comparison

		SR 99		I-5		1st Ave	
		NB	SB	NB	SB	NB	SB
Distance (miles)		6.4		6.4		3.2	
Estimated Travel Time (mins)		16.1	18.0	11.9	13.9	16.0	17.2
Speed (mph)	Estimated	23.8	21.3	32.3	27.7	12.0	11.1
	Observed	29.6	19.7	29.6	21.0	13.0	9.0
	Difference	-5.8	1.6	2.7	6.6	-1.0	2.1

As summarized in **Table 5-22**, the observed daily transit ridership is compared to the model estimates by transit service provider. Note that the model estimated daily ridership is derived from AM and MD periods as transit assignments are not performed for the remaining time periods in the PSRC model. In general, the initial model overestimated the transit ridership at the daily level. Focusing on the bus transit services where ridership by time period was provided, it is observed that the transit boarding is significantly higher in the AM and conversely lower in the MD as shown in **Table 5-23**. As discussed in the earlier section on mode choice model calibration, the mode bias constants were modified to increase transit mode shares for HBS/HBO and WBO/OBO trips which are more prominent in the off-peak periods. As a result, the final model estimates are more in-line with the observed ridership as shown in both tables. Note that while the system-wide ridership has improved with the adjustments, a bias against commuter rail services has been observed in the model. Such bias may be attributed to the practice adopted in the PSRC model that maximum headway was not implemented in mode choice modeling. Considering the typically lower frequency of services associated with commuter rail, its competitiveness would be negatively impacted against other transit modes (i.e. bus).

Table 5-22: System-wide Summary of Transit Boarding

Transit Routes	Type	Observed Daily Boarding	2015 Base Year Model Estimates					
			Initial			Final		
			AM	MD	Daily	AM	MD	Daily
Central Link	Light Rail	30,553	2,951	2,709	10,839	2,390	3,362	10,606
Tacoma Link	Rail	3,966	53	39	180	45	55	187
Sounder North	Rail	14,063	0	0	0	0	0	0
Sounder South	Rail		979	0	2,190	435	0	973
Sound Transit Express	Bus	62,237	29,257	18,195	93,912	21,934	22,961	84,985
King County Metro	Bus	403,660	145,948	94,619	474,497	109,724	124,914	440,856
Total		514,479	179,188	115,562	581,618	134,528	151,293	537,606

Table 5-23: Summary of Transit Boarding for Selected King County/Sound Transit Express Bus Lines

Time Period	Total # Routes	Observd Boarding	2015 Base Year Model Estimates					
			Initial			Final		
			Boarding	Est/Obs	Diff	Boarding	Est/Obs	Diff
AM	208	109,929	138,442	1.26	28,513	122,915	1.12	12,986
MD	144	134,316	83,825	0.62	-50,491	125,500	0.93	-8,816

5.5 BASE YEAR SUBAREA DYNAMIC TRAFFIC ASSIGNMENT MODEL

As necessitated for the investment grade T&R study, the project team was tasked to implement a more robust modeling process using the DTA algorithm to evaluate toll traffic diversion and project future year traffic for the SR 99 tunnel. Prior to this effort, the validity of the corresponding model platform was evaluated. For a prior study, a DTA model inherited from the Alaskan Way Viaduct & Seawall Replacement Project (AWV project) was employed and underwent minor modifications for the study. While this model platform was again retained for the investment grade study, several components were significantly enhanced. The model development and calibration relating to this effort is summarized in the following sections.

5.5.1 MODEL DEVELOPMENT

The objective of utilizing the subarea DTA model is to provide the final model-based traffic and revenue estimates to prepare the investment grade forecasts, with a higher network definition and more robust approach to modeling traffic movements within the SR 99 study area.

The prior analysis DTA model platform was used as the basis, where the time-of day periods for the simulation were retained, which include a 3.5-hour AM period model (5:30am to 9am) and a 5-hour MD/PM period model (1pm to 6pm). A series of model enhancements were implemented, which include the followings:

- Traffic analysis zone system to reflect regional TDM (PSRC 4K) zonal structure
- Highway network refinement to support revised TAZ system, to reflect base year roadway connectivity and expanded network coverage
- Travel demand patterns reflective of 2015 base year condition and compatible with the DTA model from regional TDM

5.5.2 Traffic Analysis Zone System

As an initial task of the model modification, the internal zone system of the DTA model was updated to maintain consistency with the current PSRC 4K model TAZ system. It is necessary to establish direct linkage between the two model platforms, so that the vehicle demand patterns estimated by the upstream regional model can be transferred to the downstream subarea model for detailed route choice modeling using the DTA algorithm.

The networks were modified from the pre-existing 125 internal traffic zones to the 300+ zone system to correspond to the PSRC 4K TAZ system with higher resolution. This effort involved creating new or renaming existing TAZ centroids and creating connectors (i.e. virtual links as referred to in Dynameq) for trips to be properly loaded onto the network, which required the creation of additional driveways or collector/local roads to accomplish this task.

5.5.3 Highway Network

As discussed in an earlier section, the SR 99 DTA model roadway network was adopted from the prior T&R study, where its base year network reflects year 2010 condition. The network covers an area of the City of Seattle, centering in the downtown area and is bounded, approximately, by the following roadways:

- NW Market/N 50th Streets to the north;
- Spokane Street Viaduct/West Seattle Bridge to the south;
- I-5/Broadway E to the east, and;
- 5th Ave W and Puget Sound to the west.

The definition of the pre-existing network was considered to be very high, particularly in the downtown grid area where all streets in the roadway network are included in the model. However, as discussed in the regional model development sections earlier in this chapter, it was necessary to perform a modification process to update the highway network from year 2010 to 2015 condition. The roadway projects included the realigned SR 99, the impacted area in the northern and southern ends of the future toll tunnel, as well as other notable/significant highway improvement projects previously mentioned.

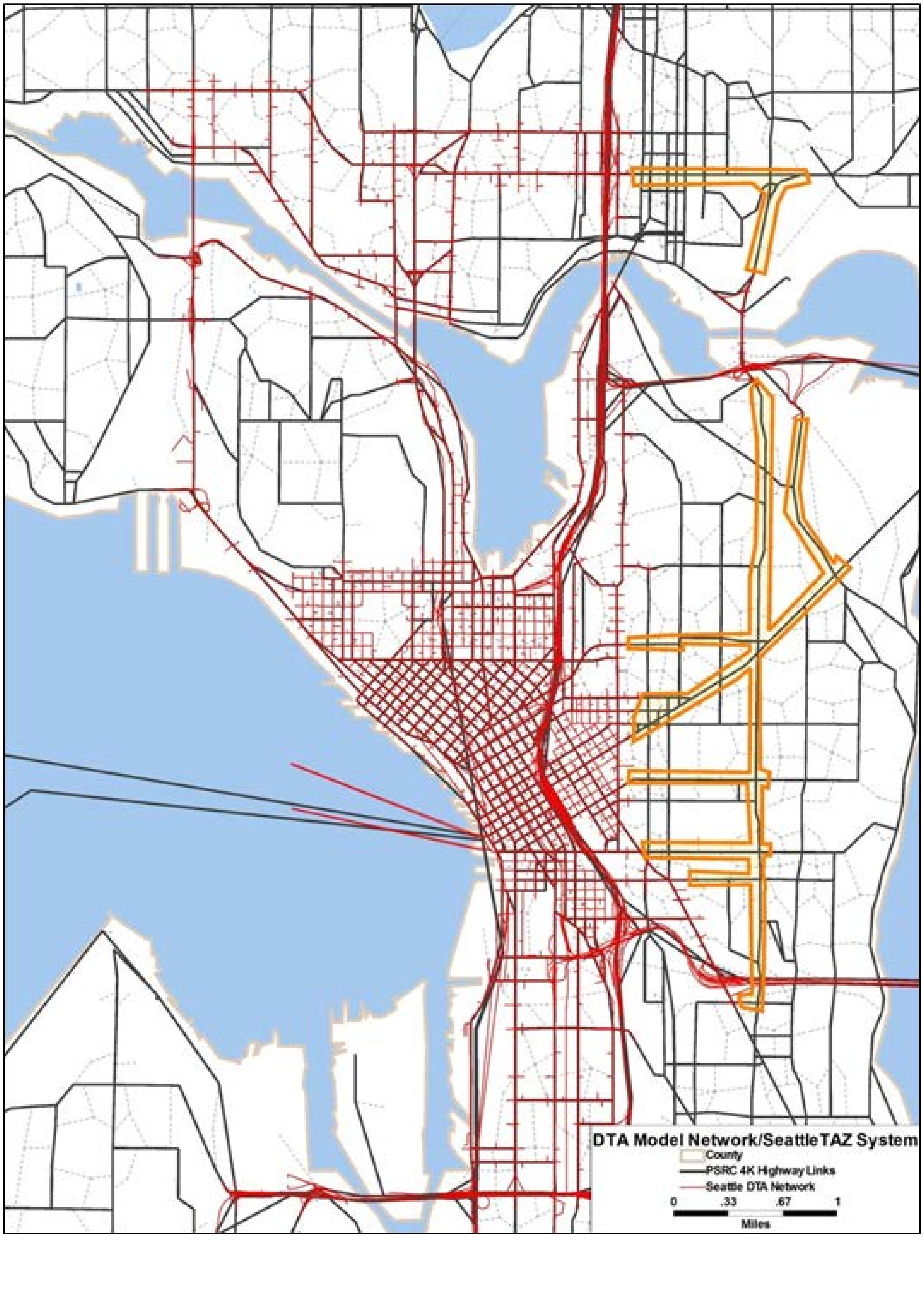
As a further enhancement to the model, coverage of the highway network has been extended eastward to incorporate parallel competing travel routes (23rd/24th Ave E) to I-5. As the result of

a recent review of the existing SR 99 DTA network, a north-south corridor that did not exist in the DTA network was been identified as a logical alternative route to I-5 with potential for significant traffic diversion pertinent in the future year. This continuous corridor, which was added into the DTA study area, includes several arterial road sections: SR 513 from N 45th Street to SR 520 and 23rd/24th Avenue E from SR 520 to S. Massachusetts St (immediately south of I-90).

As part of this effort, special attention had been exercised to examine certain PSRC zones for inclusion/exclusion into the DTA network near the external cordon area. Ideally, the DTA network should logically include the PSRC zones that are wholly within its coverage, which required minor adjustments to network to accomplish this task.

As shown in **Figure 5-4**, the pre-existing DTA network is overlaid onto the PSRC 4K model network. The network sections as identified above for incorporation as they exist in the PSRC model is highlighted in orange. Additional TAZs from the PSRC 4k Model along the expanded network coverage were also incorporated.

Figure 5-4: Expanded SR 99 DTA Model Network Coverage



5.5.4 Travel Demand

An "initial" set of travel demand patterns was computed for the DTA model, using the vehicle trip matrices as estimated by the 2015 base year regional TDM as primary input travel demand assumptions. Due to the inherent differences in geographical coverage, network definition, and temporal profiles between the two modeling platforms, a preparation process was developed and implemented to convert the associated travel patterns into a format as required by the DTA model. This process involves several individual steps:

- Subarea travel demand matrix extraction from regional TDM
- Matrix estimation process to refine flow pattern to better reflect observed link traffic volumes
- Consolidation of vehicle demand classes
- Application of temporal profile

The first step is to overcome the spatial compatibility issue between the two modeling platforms with respect to the level of geographical coverage. A sub-set of travel demand matrices were extracted from the regional TDM to the subarea model level utilizing the "traversal analysis" process as referred to in the EMME software. A subarea boundary reflecting the DTA model network coverage was defined, so that the correspondence between external stations (or "gates") and internal zones could be established. An attribute "@gate" defining the boundary of the subarea was then specified to the network and used as a critical input to this process. The traversal analyses were performed to extract demand matrices from the relevant PSRC model periods of AM (6am to 9am), MD (9am to 3pm), and PM (3pm to 6pm) covering the two equivalent DTA model periods.

Immediately following the extraction process, another post-processing step, commonly known as origin-destination matrix estimation (ODME), was applied. The objective of this process is to adjust the travel patterns to better match the observed link traffic volumes, so that appropriate traffic patterns and intensity can be more realistically reflected in the DTA algorithm. The concept is to refine the flow patterns from the regional TDM by minimizing the differences between the observed traffic volumes and the model estimated flows corresponding to the seed travel patterns. In the EMME software, this process is known as "Traffic Demand Adjustment". The demand adjustment step requires a specification file for the traffic assignment (consistent with the regional TDM assignment methodology) in the procedure and a specification file containing the demand adjustment parameters. The basic inputs to the matrix estimation process include the seed matrices extracted from the regional TDM and the time period link counts.

While the PSRC 4K model maintains 11 vehicle classes for highway assignment process as discussed in the earlier section, the input origin-destination vehicle trip matrices considered in the subarea DTA model include 6 vehicle types (or "demand classes" in Dynameq) by aggregating the HBW and other purposes into all-purpose SOV vehicles and merging HOV3+ and Vanpool into a single class. The demand classes as input to the DTA model are defined as below:

1. SOV
2. HOV2
3. HOV3+
4. Light Truck
5. Medium Truck
6. Heavy Truck

The final step in the trip table post-processing procedure is the stratification of demand matrices into 15-minute time intervals for each simulation period (note that in the AM period DTA model, the additional time intervals between 5:30am and 6am were extrapolated from 6am to 9am demand). Using applicable observed traffic counts, specific inbound and outbound temporal profiles for individual external stations representing major roadway facilities (i.e. I-5, SR 99, I-90 and SR 520) or other arterial roads were developed and applied accordingly. For other zones without any relevant traffic counts, a generic set of temporal profile patterns derived from the average of all available traffic counts, would be used to reflect the building up of traffic within corresponding time periods.

Note that additional adjustments to the vehicle demand matrices were performed as part of the model calibration process.

5.5.5 MODEL VALIDATION DATA

As the DTA subarea covers a smaller geographic area, a subset of the overall observed dataset was used. Different requirements, however, are necessary for this separate dataset to establish existing traffic conditions suitable for the DTA model calibration effort.

The recently-collected and WSDOT ATR traffic counts organized as screenlines were used as the primary data source. The traffic volumes were summarized at 15-minute intervals to provide temporal distribution assumptions and at the hourly level for model validation purposes. This dataset was supplemented by turning-movement counts (TMC) collected in the downtown Seattle area.

In addition to traffic volume data, the speed/travel time dataset was compiled from the INRIX data, supplemented by SR 99 project-specific speed runs and SigAlert data for verification purposes. Appropriate travel time routes were constructed for model validation purposes.

Streetlight data were obtained to provide observations at corridor-level by capturing ramp-to-ramp movements for existing SR 99 and I-5 corridors. As part of the model validation process, select-link analyses were performed to extract the DTA model estimation and compare results with the observed O-D information.

5.5.6 MODEL CALIBRATION AND VALIDATION

The DTA model calibration effort is an endeavor to replicate the observed base year traffic condition, focusing on hourly traffic volumes, as well as the observed travel time/speed data and ramp-to-ramp travel patterns. An iterative approach to calibrate the DTA model was implemented.

As an initial effort, the initial vehicle demand matrices developed from the regional TDM were assigned to the modified highway model network. The results from this initial set of model runs were then evaluated against the observed hourly traffic volumes for significant over/under-assignment, and against observed travel time for discrepancies. As necessary, the following adjustments to the network were conducted to achieve gradual improvements in the DTA model:

- Adjustment to geometric detail at the localized level, which included verifying and modifying, as necessary, physical characteristics of the roadway network, such as the number of lanes, free-flow speeds and connectivity (i.e. turn movements, prohibitions) along major roadways (e.g. I-5 and SR 99) and high congested areas (e.g. downtown and its surrounding neighborhoods);

- Optimization of traffic signals for intersections where no real information is provided;
- Adjustments of vehicle loading locations (i.e. relocating or adding centroid connectors);
- Adjustments of vehicle generation patterns;
- Adjustment of link cost functions and path selection modeling parameters, and;
- Adjustment of network-wide driving behavior including response factors ("resfac") and vehicle length factors ("lenfac").

This network modification effort would continue until further improvements to model results were progressively diminished. As a subsequent step, additional refinements to the O-D matrices were performed, which included the adjustments of inbound /outbound traffic at external stations, as well as temporal profiles at specific network locations to address any potential deficiencies in the travel demand model not directly related to the highway network coding. The comparison between the initial subarea trip matrices, as extracted from the regional TDM, and the final version for DTA modeling is provided in **Table 5-24**, showing minor differences in overall demand to the subarea. The validity of the model was then re-evaluated and further refinements to the network were performed as necessary to achieve acceptable model results in comparison to observed data.

Table 5-24: Comparison of DTA Subarea Trip Matrices by Time Period

Vehicle Class	AM (6:00 to 9:00)				Mid-Day (9:00 to 3:00)				PM (3:00 to 6:00)			
	Initial	Final	Diff	%Diff	Initial	Final	Diff	%Diff	Initial	Final	Diff	%Diff
SOV	218,737	220,125	1,388	0.6%	415,062	420,975	5,913	1.4%	243,309	243,837	528	0.2%
HOV2	36,737	36,028	-709	-1.9%	90,375	91,408	1,032	1.1%	67,111	65,583	-1,527	-2.3%
HOV3+	17,265	16,869	-396	-2.3%	48,196	48,750	555	1.2%	33,119	32,179	-941	-2.8%
Light Truck	21,905	22,526	621	2.8%	39,007	40,592	1,586	4.1%	27,009	27,095	85	0.3%
Medium Truck	5,780	5,941	161	2.8%	11,612	12,254	642	5.5%	5,649	5,874	225	4.0%
Heavy Truck	5,711	5,938	227	4.0%	12,770	13,423	653	5.1%	5,140	5,337	197	3.8%
Total	306,134	307,426	1,292	0.4%	617,021	627,402	10,381	1.7%	381,338	379,905	-1,433	-0.4%

5.5.7 Model Validation

For DTA model validation purposes, a set of model summary statistics were summarized and compared with observed traffic data.

In consideration of validation standards obtained from different available sources, a set of criteria, which includes traffic volumes by screenline and individual corridors, were established for the purpose of validating the existing alignment of SR 99 and its competing routes within the primary study area. In addition, the observed average hourly congested speed by travel time routes and origin/destination ramp-to-ramp movements by time period are also compared with the model estimates to further ensure the validity of the base year model and the ability to sufficiently reflect existing traffic conditions. Additional comparisons of the observed counts and model estimates for available links on an hourly basis were summarized to examine the model's ability to properly reflect the variability within a desirable deviation limit.

The average link volumes at the hourly level are provided graphically in **Figure 5-5** and **Figure 5-6**, respectively for the two modeling periods of AM (5:30am to 9am) and MD/PM (1pm to 6pm), where the increase of traffic for both models are closely reflecting the observed temporal profiles at a network-wide level.

The overall fit of the estimated traffic to the observed volumes are further demonstrated by analyzing the percent Root Mean Square Error (RMSE). RMSE is the standard deviation of the residuals (prediction errors). Residuals are a measure of how far from the regression line data points are; RMSE is a measure of how spread out these residuals are. In other words, it tells you how concentrated the data is around the line of best fit.

RMSE by volume group at the hourly level is shown in **Figure 5-7** and **Figure 5-8**, showing a set of logical patterns where the RMSE is progressively decreasing from lower to higher volume groups. In addition, the scatter plots comparing observed and model estimated midblock link volumes at the hourly level are provided from **Figure 5-9** through **Figure 5-16**. As can be noted from the plots, the observed and model estimated traffic volumes are strongly correlated with R^2 values above 0.9 for all hours within both modeling periods.

Figure 5-5: Average Hourly Link Volume (AM Period)

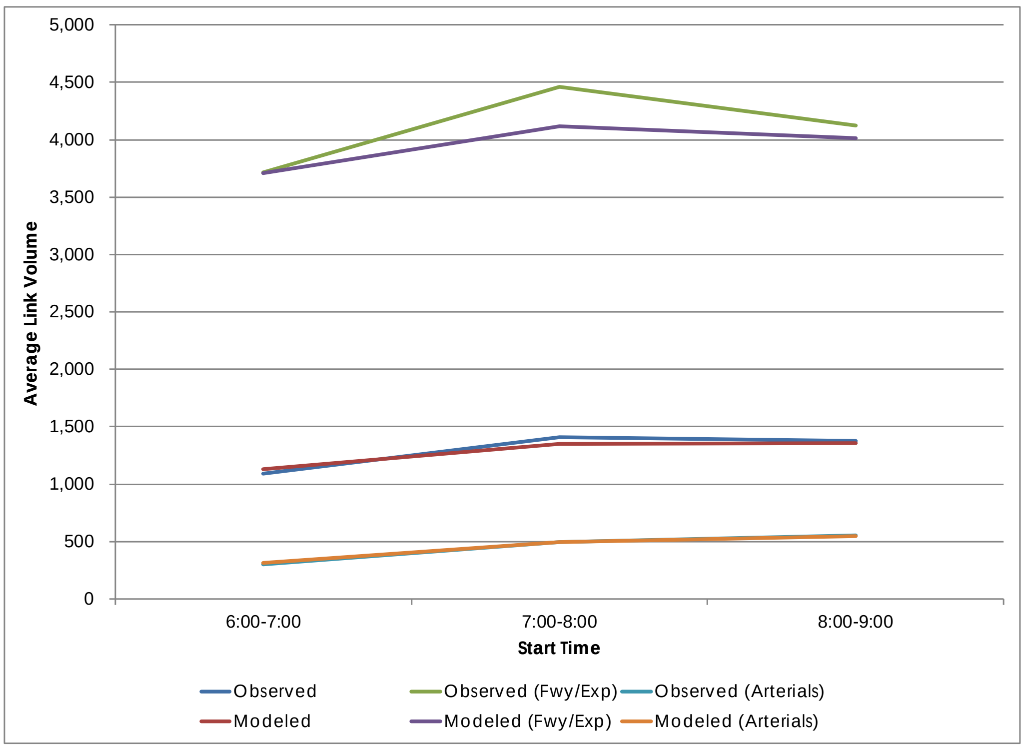


Figure 5-6: Average Hourly Link Volume (MD/PM Period)

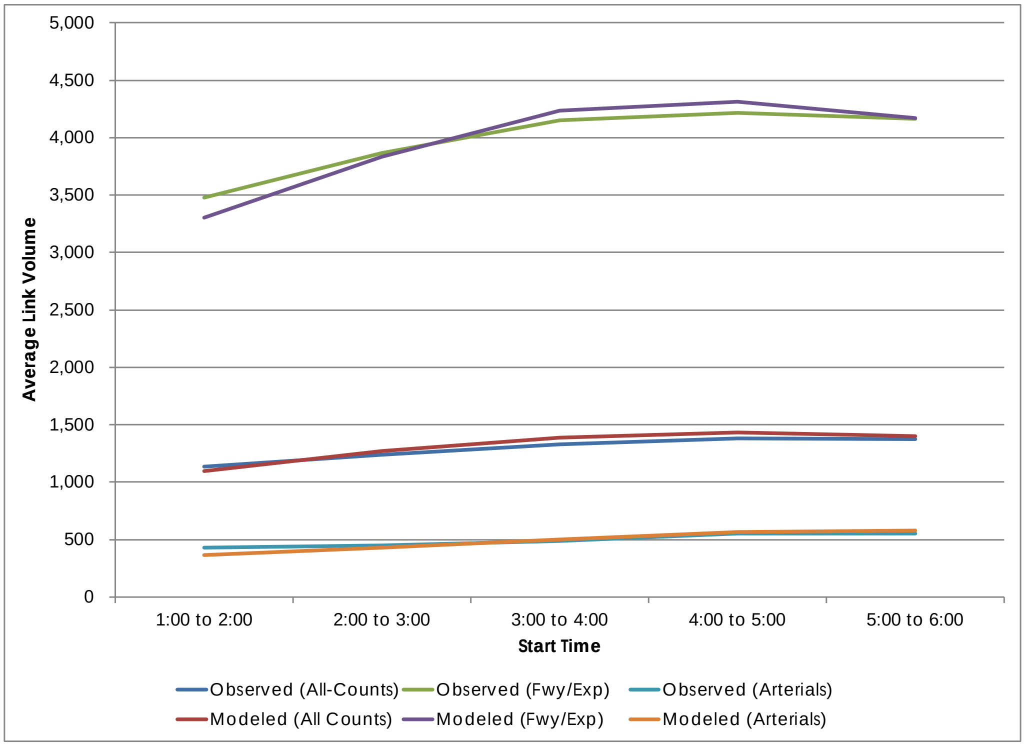


Figure 5-7: Percent RMSE by Volume Group (AM Period)

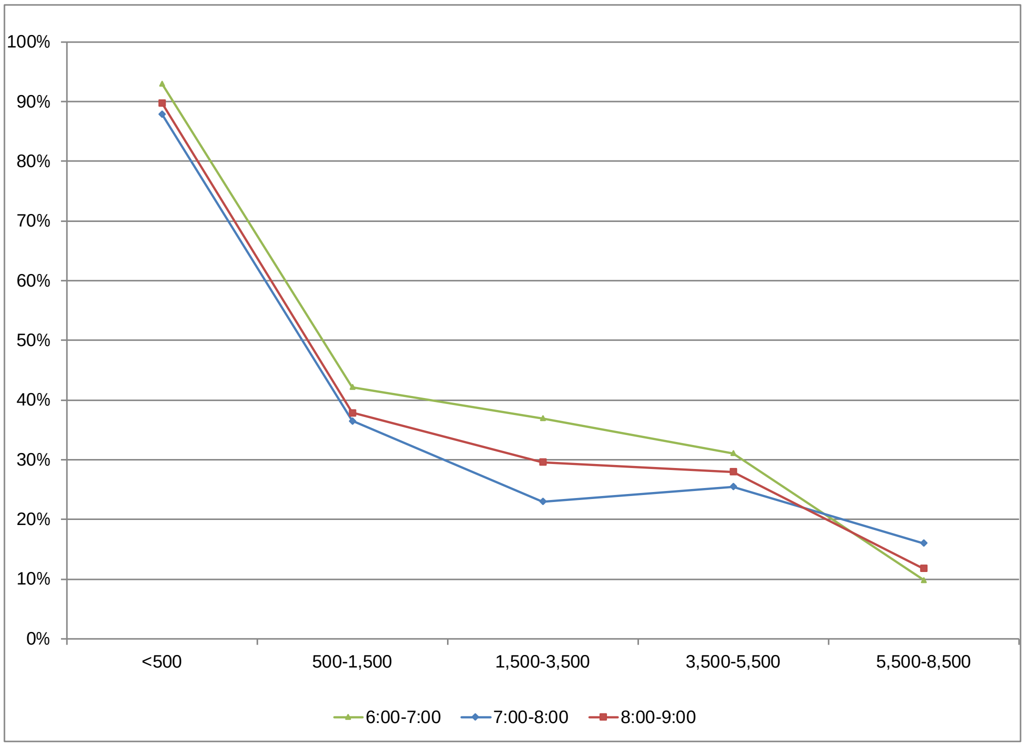


Figure 5-8: Percent RMSE by Volume Group (MD/PM Period)

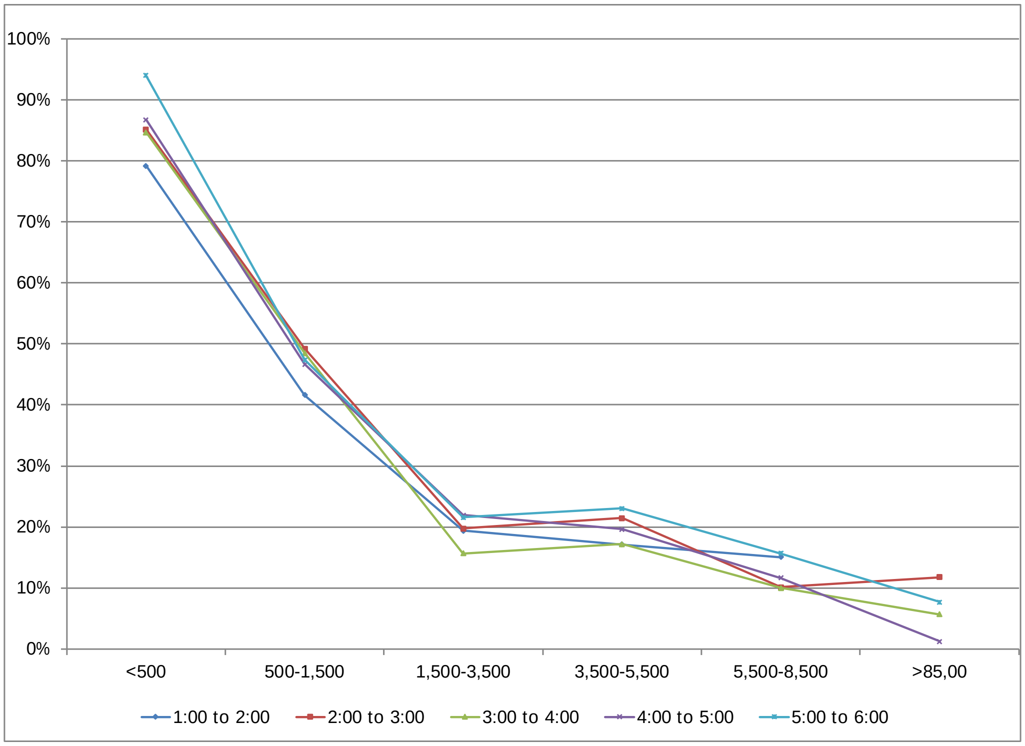


Figure 5-9: Scatter Plot of Hourly Link Volume (6 to 7am)

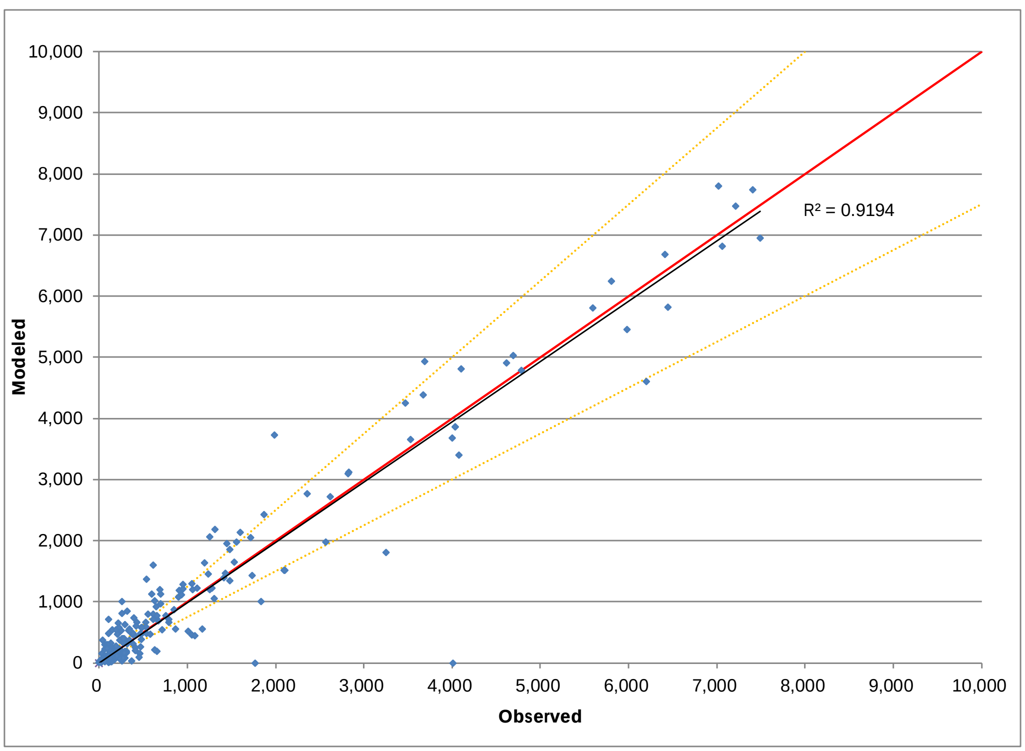


Figure 5-10: Scatter Plot of Hourly Link Volume (7 to 8am)

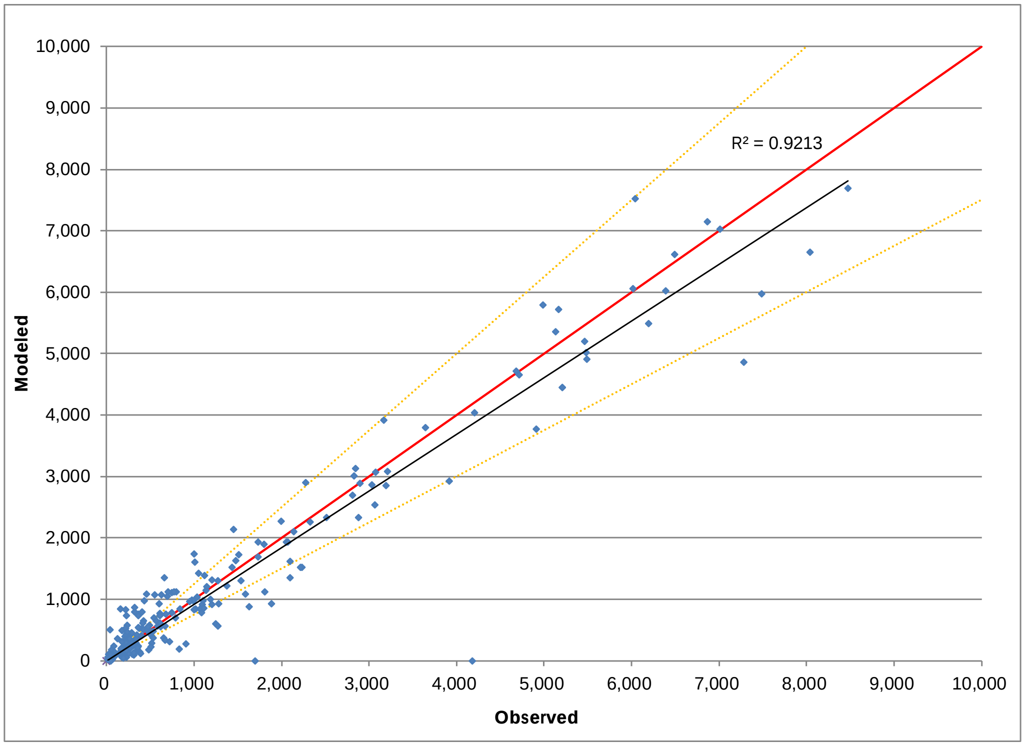


Figure 5-11: Scatter Plot of Hourly Link Volume (8 to 9am)

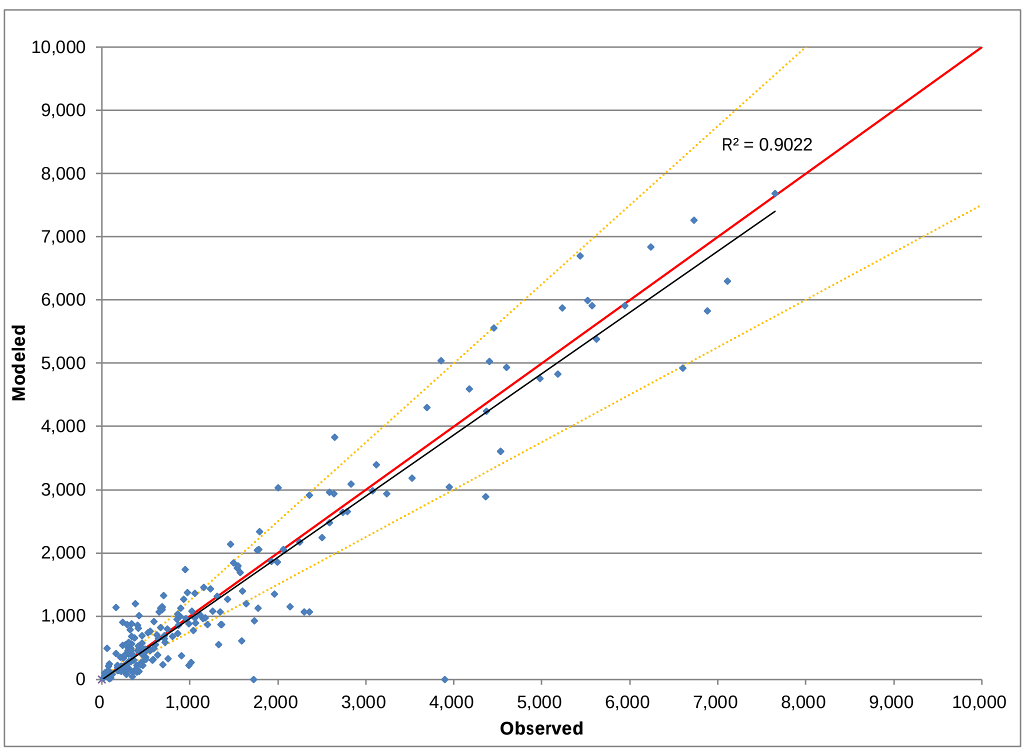


Figure 5-12: Scatter Plot of Hourly Link Volume (1 to 2pm)

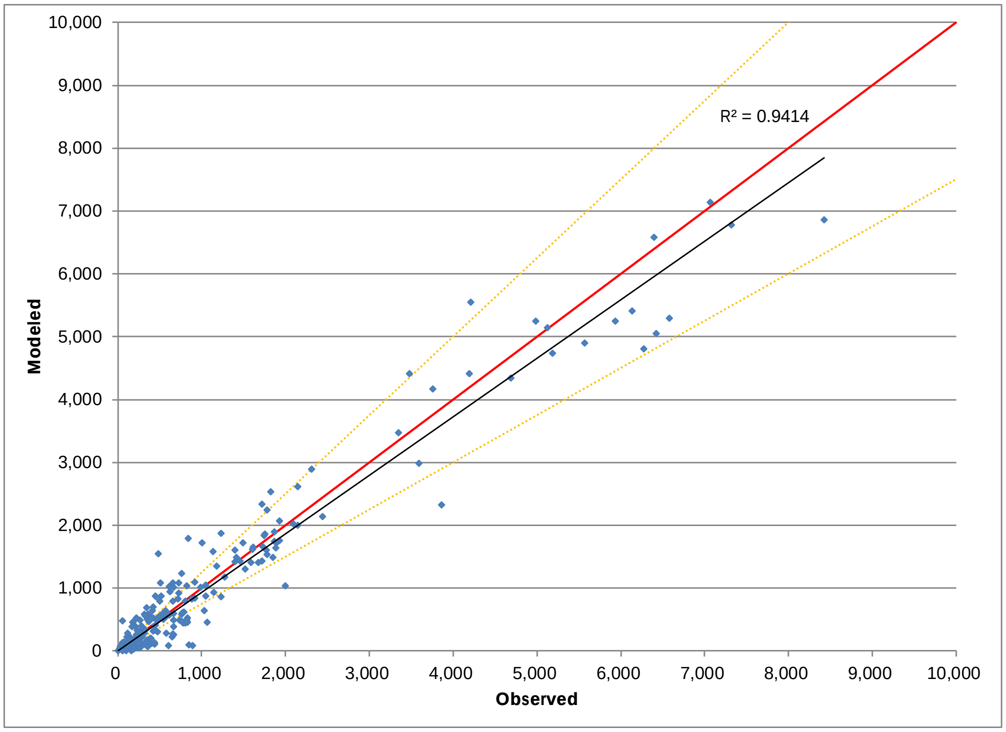


Figure 5-13: Scatter Plot of Hourly Link Volume (2 to 3pm)

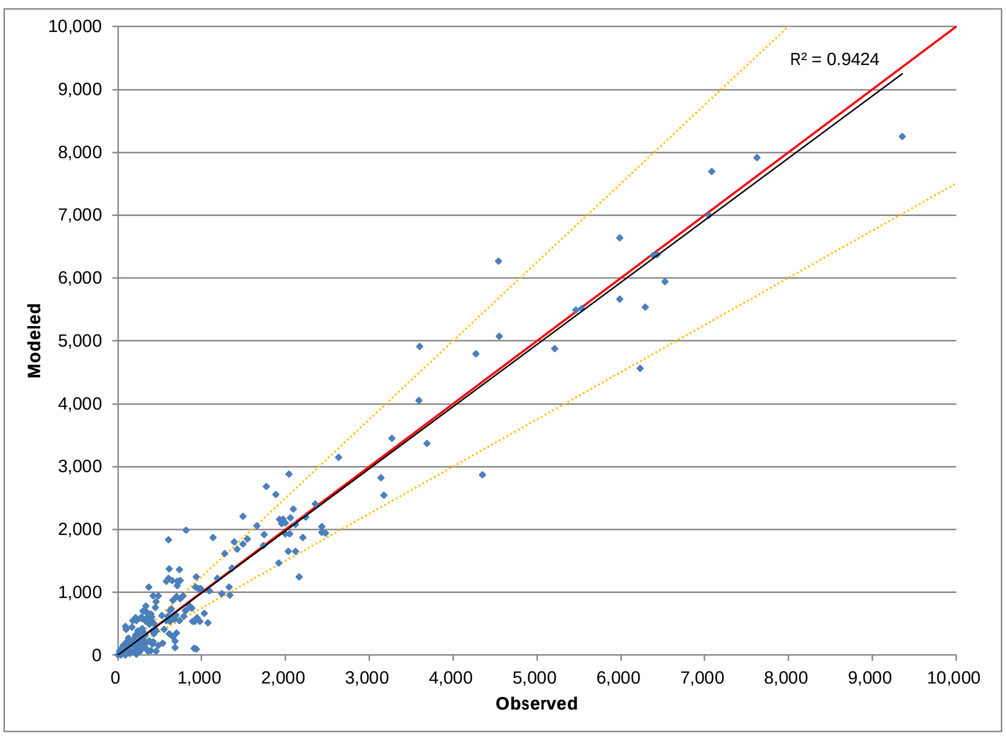


Figure 5-14: Scatter Plot of Hourly Link Volume (3 to 4pm)

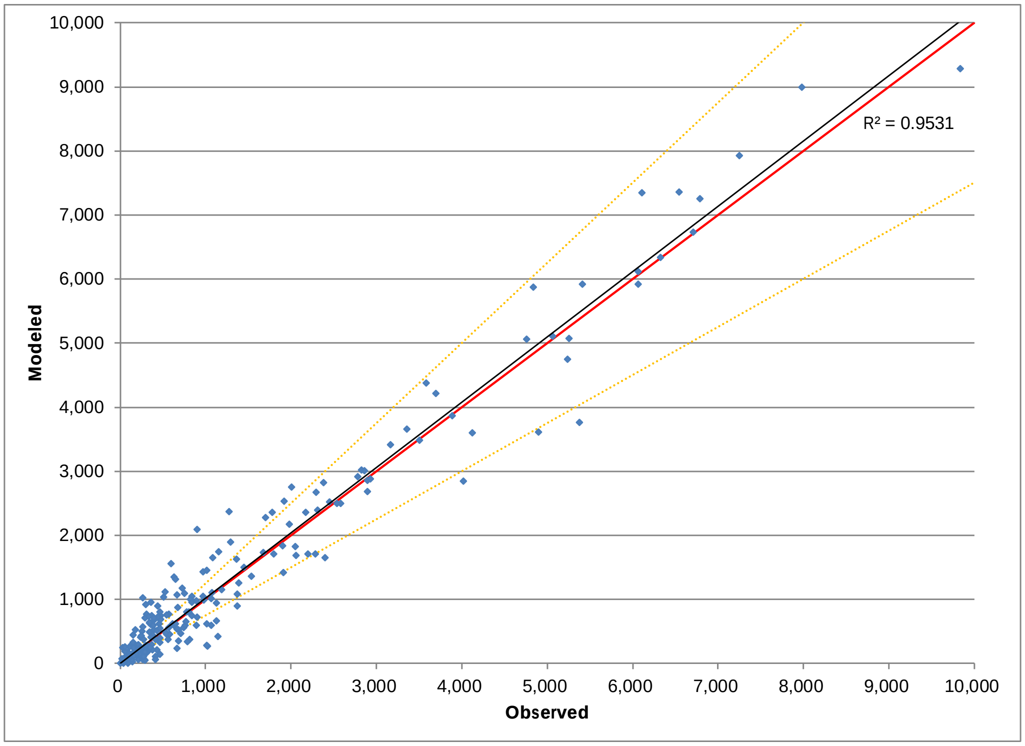


Figure 5-15: Scatter Plot of Hourly Link Volume (4 to 5pm)

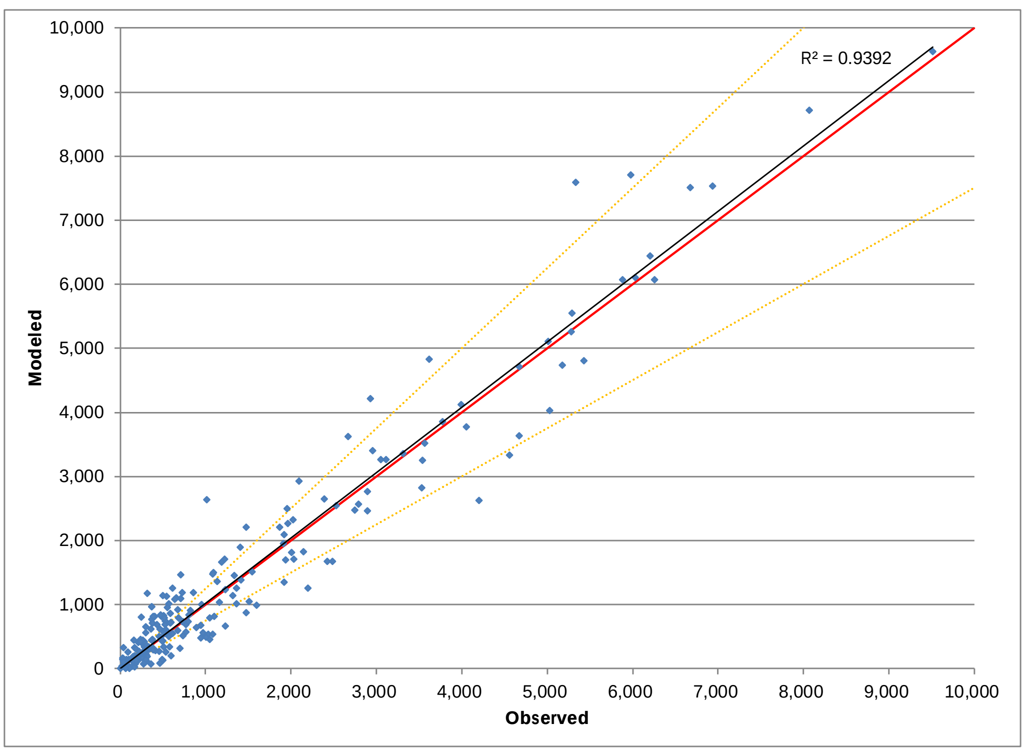
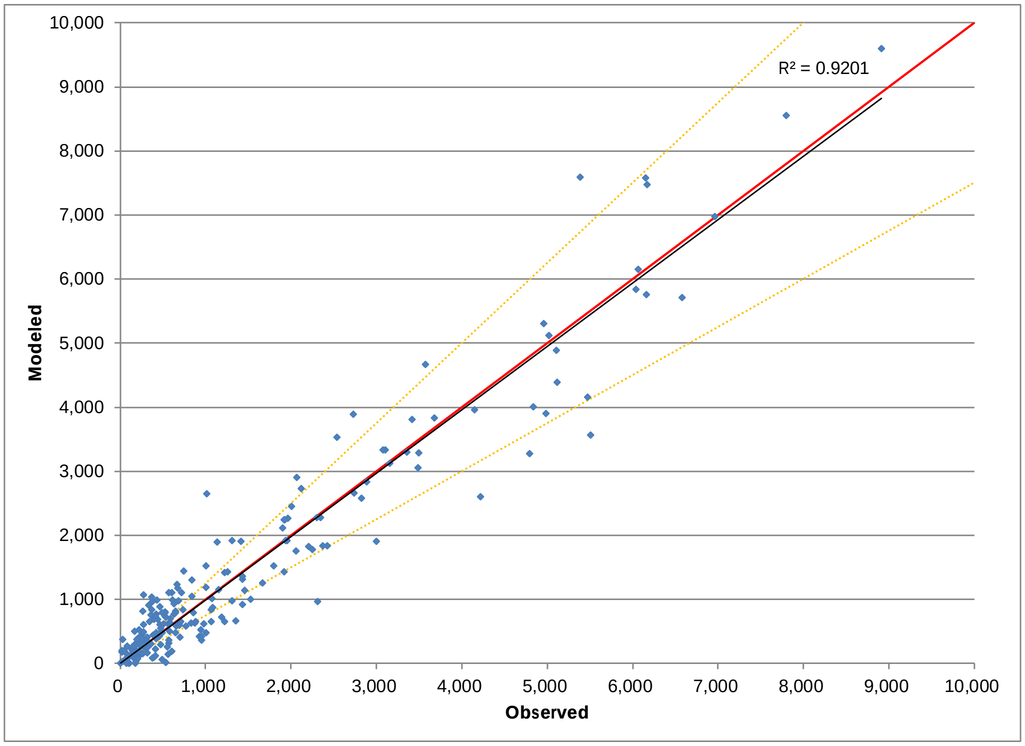


Figure 5-16: Scatter Plot of Hourly Link Volume (5 to 6pm)



With the replication of overall traffic levels within the study area being confirmed, the validity of the model will be further examined in terms of traffic patterns. The screenline traffic volumes by direction are provided in **Table 5-25** and **Table 5-26** for the AM period and in **Table 5-27** and **Table 5-28** for the PM period. In general, the estimated traffic for individual screenlines are matched to within 5 percent of the observed volume for the north-south and Lake Washington (including SR 520 and I-90) screenlines, indicating that the overall traffic levels and travel pattern estimations are reflective of the observed condition.

Focusing on the major north-south thoroughfares of SR 99 and I-5 more specifically, the observed traffic flows are compared to the model estimates at specific sections by direction, as shown in **Table 5-29** and **Table 5-30** for the AM period and **Table 5-31** and **Table 5-32** for the PM period. While the model estimates are typically matched within 10 percent of observed volumes and reflective of hourly profiles within corresponding time periods, some higher variations of discrepancies at specific locations are noted, which are typically found further from the future SR 99 toll tunnel. These differences may be due to localized routing issues where the effect on future year toll tunnel would likely to be limited.

Ramp-to-ramp traffic movements, as computed from the Streetlight data, are compared with the model estimates extracted from select link analysis for respective peak periods, and are summarized in **Table 5-33** and **Table 5-34**. While some variations may be noticeable between adjacent on/off ramps, the model estimates are reflective of the observed data.

In addition to traffic volume comparison, the congested travel speeds by roadway corridor estimated by the model were also examined as a secondary level of validity check. The comparisons are provided by time period and direction as shown in **Table 5-35**, **Table 5-36**, **Table 5-37**, and **Table 5-38**. As shown in the corresponding tables, the model estimated travel speeds

are, in general, reflective of the observed speeds within the corresponding time period for SR 99 and other north-south arterials. As noted in the summary tables, however, a higher degree of discrepancy in congested speeds are observed on I-5, where the severity of traffic was not fully replicated by the DTA model. While it is understood that I-5 traffic congestion is mostly attributed to the weaving of traffic relating to merging and diverging between on/off ramps, it would be reasonable to modify the speed-flow relationship on specific freeway links at a localized level to rectify such issues. This approach, however, would likely create unrealistic traffic diversion to adjacent arterial roads and resulting system-wide failure. Where actual conditions could not be reflected perfectly in the DTA model, an effort was made to ensure that the model would forecast a conservative estimate of traffic and revenue for the project.

Table 5-25: Summary of NB/EB Screenline Traffic Volumes/Hourly Profiles (AM Period)

Screenline Code	Screenline Name	Traffic Volume			Temporal Profile					
					Observed			Estimates		
		Observed	Estimated	%Diff	6:00 AM	7:00 AM	8:00 AM	6:00 AM	7:00 AM	8:00 AM
NS-1	Ship Canal	34,348	37,023	8%	24%	37%	39%	26%	36%	38%
NS-2	South Of Mercer	30,424	30,037	-1%	26%	36%	38%	28%	35%	36%
NS-3	North Of Seneca	38,868	38,029	-2%	29%	35%	35%	31%	35%	35%
NS-4	South Of S Jackson	43,525	41,664	-4%	30%	35%	35%	32%	34%	34%
NS-5	South Of S Massachusetts	40,122	37,867	-6%	32%	35%	33%	33%	34%	34%
NS-6	North Of Spokane	38,157	34,727	-9%	32%	35%	33%	32%	34%	33%
EW-1	Northeast of 3rd Ave	7,081	8,671	22%	21%	36%	43%	26%	35%	38%
EW-2	Lake Washington	22,863	22,761	0%	24%	38%	38%	25%	35%	40%

Table 5-26: Summary of SB/WB Screenline Traffic Volumes/Hourly Profiles (AM Period)

Screenline Code	Screenline Name	Traffic Volume			Temporal Profile					
					Observed			Estimates		
		Observed	Estimated	%Diff	6:00 AM	7:00 AM	8:00 AM	6:00 AM	7:00 AM	8:00 AM
NS-1	Ship Canal	60,499	59,351	-2%	25%	38%	37%	28%	36%	36%
NS-2	South Of Mercer	47,238	42,078	-11%	26%	36%	38%	28%	36%	36%
NS-3	North Of Seneca	41,265	37,073	-10%	28%	37%	35%	29%	35%	36%
NS-4	South Of S Jackson	35,190	37,679	7%	29%	37%	34%	29%	35%	36%
NS-5	South Of S Massachusetts	33,212	32,594	-2%	30%	37%	33%	30%	35%	35%
NS-6	North Of Spokane	27,194	28,068	3%	29%	37%	33%	29%	35%	36%
EW-1	Northeast of 3rd Ave	10,143	10,437	3%	21%	35%	44%	24%	36%	40%
EW-2	Lake Washington	26,454	26,333	0%	26%	38%	36%	30%	35%	34%

Table 5-27: Summary of NB/EB Screenline Traffic Volumes/Hourly Profiles (MD/PM Period)

Screenline Code	Screenline Name	Traffic Volume			Temporal Profile									
					Observed					Estimated				
		Observed	Estimated	%Diff	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM
NS-1	Ship Canal	97,139	96,076	-1%	15%	18%	21%	23%	24%	15%	18%	21%	23%	23%
NS-2	South Of Mercer	77,130	77,403	0%	16%	18%	20%	22%	23%	15%	18%	22%	23%	22%
NS-3	North Of Seneca	70,488	66,179	-6%	17%	18%	21%	22%	22%	16%	19%	21%	22%	21%
NS-4	South Of S Jackson	65,828	65,149	-1%	18%	20%	21%	21%	20%	18%	20%	21%	21%	20%
NS-5	South Of S Massachusetts	62,161	58,929	-5%	18%	19%	21%	22%	20%	18%	20%	22%	21%	20%
NS-6	North Of Spokane	50,445	48,432	-4%	19%	20%	21%	21%	19%	18%	20%	21%	21%	20%
EW-1	Northeast of 3rd Ave	17,566	18,658	6%	17%	17%	19%	22%	25%	15%	18%	20%	23%	24%
EW-2	Lake Washington	39,682	38,281	-4%	16%	17%	20%	23%	24%	15%	18%	21%	23%	23%

Table 5-28: Summary of SB/WB Screenline Traffic Volumes/Hourly Profiles (MD/PM Period)

Screenline Code	Screenline Name	Traffic Volume			Temporal Profile									
					Observed					Estimated				
		Observed	Estimated	%Diff	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM
NS-1	Ship Canal	69,217	67,657	-2%	19%	20%	20%	20%	21%	18%	20%	20%	22%	21%
NS-2	South Of Mercer	54,090	57,395	6%	21%	20%	20%	19%	20%	17%	20%	20%	22%	21%
NS-3	North Of Seneca	63,578	62,022	-2%	18%	20%	21%	21%	20%	16%	19%	21%	22%	22%
NS-4	South Of S Jackson	72,163	70,469	-2%	17%	19%	21%	22%	21%	16%	19%	22%	22%	21%
NS-5	South Of S Massachusetts	67,598	65,256	-3%	17%	19%	21%	22%	21%	14%	17%	22%	23%	24%
NS-6	North Of Spokane	62,550	58,880	-6%	17%	19%	22%	22%	20%	14%	17%	22%	23%	24%
EW-1	Northeast of 3rd Ave	16,915	13,698	-19%	18%	18%	19%	22%	22%	15%	20%	20%	23%	23%
EW-2	Lake Washington	37,322	38,711	4%	16%	18%	21%	22%	22%	16%	19%	21%	22%	22%

Table 5-29: Summary of NB Major Corridor Traffic Volumes and Temporal Profile (AM Period)

Facility Name	Section	Volume			Hourly Profile (Observed)			Hourly Profile (Estimated)		
		Observed	Estimated	%Diff	6:00 AM	7:00 AM	8:00 AM	6:00 AM	7:00 AM	8:00 AM
I-5	N. of Ravenna Blvd	14,121	14,097	0%	25%	39%	37%	30%	36%	34%
	At Ship Canal	16,060	16,777	4%	26%	37%	37%	29%	36%	35%
	S. of Mercer St	15,805	15,495	-2%	27%	36%	37%	31%	35%	34%
	At Seneca St	17,801	16,330	-8%	34%	35%	32%	33%	34%	33%
	S. of Jackson St	25,927	26,706	3%	33%	34%	33%	34%	33%	33%
	At S Holgate St	20,094	22,028	12%	37%	33%	29%	35%	34%	30%
	At Spokane St	15,377	16,990	10%	38%	34%	29%	37%	34%	30%
	At S Oregon St	19,463	20,268	4%	38%	33%	29%	38%	33%	29%

Facility Name	Section	Volume			Hourly Profile (Observed)			Hourly Profile (Estimated)		
		Observed	Estimated	%Diff	6:00 AM	7:00 AM	8:00 AM	6:00 AM	7:00 AM	8:00 AM
SR 99	S. of N 46th St Ramps	2,892	3,628	25%	21%	39%	40%	22%	38%	40%
	At Ship Canal	5,805	5,670	-2%	24%	37%	39%	25%	37%	38%
	S. of Mercer St	6,365	6,145	-3%	24%	37%	39%	27%	37%	37%
	N. of Seneca St	8,772	8,768	0%	30%	35%	35%	31%	35%	34%
	S. of Jackson St	11,117	11,478	3%	29%	35%	35%	32%	34%	33%
	S. of S Massachusetts St	8,239	9,067	10%	34%	34%	31%	34%	33%	33%
	N. of Spokane St	8,306	9,181	11%	34%	34%	32%	34%	34%	32%

Table 5-30: Summary of SB Major Corridor Traffic Volumes and Temporal Profile (AM Period)

Facility Name	Section	Volume			Hourly Profile (Observed)			Hourly Profile (Estimated)		
		Observed	Estimated	%Diff	6:00 AM	7:00 AM	8:00 AM	6:00 AM	7:00 AM	8:00 AM
I-5	N. of Ravenna Blvd	16,277	20,815	28%	35%	34%	31%	33%	34%	33%
	At Ship Canal	20,154	20,964	4%	32%	35%	33%	32%	34%	35%
	S. of Mercer St	18,819	17,633	-6%	30%	34%	35%	33%	35%	32%
	At Seneca St	20,084	18,107	-10%	31%	36%	33%	32%	34%	34%
	S. of Jackson Street	25,225	26,849	6%	31%	36%	33%	33%	34%	33%
	At S Holgate St	20,477	20,420	0%	32%	36%	32%	37%	33%	31%
	At Spokane Street	17,507	17,820	2%	32%	37%	32%	33%	34%	34%
	At S Oregon Street	23,614	22,339	-5%	32%	36%	32%	31%	34%	34%
I-5 Exp	N. of Ravenna Blvd	13,351	10,053	-25%	31%	37%	33%	34%	37%	29%
	At Ship Canal	13,772	11,919	-13%	29%	38%	33%	32%	37%	30%
	S. of Mercer Street	6,619	4,097	-38%	32%	34%	35%	37%	37%	26%
	At Seneca Street	6,696	4,097	-39%	31%	33%	35%	37%	37%	26%
I-5 (Total)	N. of Ravenna Blvd	29,628	30,868	4%	33%	35%	32%	33%	35%	32%
	At Ship Canal	33,926	32,883	-3%	31%	36%	33%	32%	35%	33%
	S. of Mercer Street	25,438	21,861	-14%	31%	34%	35%	34%	35%	31%

Facility Name	Section	Volume			Hourly Profile (Observed)			Hourly Profile (Estimated)		
		Observed	Estimated	%Diff	6:00 AM	7:00 AM	8:00 AM	6:00 AM	7:00 AM	8:00 AM
SR 99	S. of N 46th St Ramps	7,287	7,963	9%	21%	40%	39%	25%	36%	39%
	At Ship Canal	9,200	10,524	14%	20%	40%	40%	23%	36%	41%
	S. of Mercer St	8,055	8,529	6%	21%	40%	39%	24%	36%	40%
	N. of Seneca St	6,902	7,041	2%	25%	41%	34%	20%	38%	41%
	S. of Jackson St	7,810	7,763	-1%	25%	41%	34%	23%	38%	39%
	S. of S Massachusetts St	5,111	5,202	2%	25%	41%	34%	24%	37%	39%
	N. of Spokane St	5,091	5,178	2%	25%	40%	35%	23%	37%	40%

Table 5-31: Summary of NB Major Corridor Traffic Volumes and Temporal Profile (PM Period)

Facility Name	Section	Volume			Hourly Profile (Observed)					Hourly Profile (Estimated)				
		Observed	Estimated	%Diff	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM
I-5	N. of Ravenna Blvd	27,940	34,315	23%	18%	21%	22%	19%	19%	15%	19%	21%	22%	22%
	At Ship Canal	30,668	33,922	11%	18%	21%	21%	19%	20%	14%	19%	22%	23%	22%
	S. of Mercer St	28,461	31,064	9%	18%	21%	22%	19%	20%	15%	19%	21%	22%	22%
	At Seneca St	28,644	28,266	-1%	18%	19%	21%	21%	21%	17%	19%	22%	21%	21%
	S. of Jackson St	41,767	45,223	8%	20%	21%	21%	19%	19%	19%	22%	21%	20%	18%
	At S Holgate St	35,234	37,270	6%	20%	20%	21%	20%	19%	19%	21%	21%	20%	19%
	At Spokane St	26,188	27,538	5%	19%	21%	21%	20%	19%	19%	20%	22%	20%	19%
	At S Oregon St	32,433	32,916	1%	20%	22%	21%	19%	19%	20%	21%	20%	20%	19%
I-5 Exp	N. of Ravenna Blvd	17,763	12,618	-29%	12%	18%	23%	24%	24%	16%	20%	23%	21%	21%
	At Ship Canal	19,065	16,546	-13%	12%	17%	22%	24%	25%	17%	21%	22%	20%	20%
	S. of Mercer St	10,622	8,291	-22%	15%	19%	21%	23%	22%	17%	20%	21%	20%	22%
	At Seneca St	10,983	8,291	-25%	15%	19%	21%	23%	22%	17%	20%	21%	20%	22%
I-5 (Total)	N. of Ravenna Blvd	45,703	46,933	3%	16%	20%	22%	21%	21%	15%	20%	22%	22%	22%
	At Ship Canal	49,733	50,468	1%	16%	19%	21%	21%	22%	15%	19%	22%	22%	22%
	At Seneca St	39,083	39,355	1%	17%	20%	21%	20%	21%	16%	19%	21%	22%	22%

Facility Name	Section	Volume			Hourly Profile (Observed)					Hourly Profile (Estimated)				
		Observed	Estimated	%Diff	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM
SR 99	S. of N 46th St Ramps	10,682	12,445	17%	11%	13%	19%	28%	30%	11%	15%	22%	27%	25%
	At Ship Canal	15,439	15,436	0%	12%	15%	21%	26%	27%	11%	14%	22%	27%	26%
	S. of Mercer St	13,621	12,773	-6%	13%	15%	20%	26%	26%	13%	15%	23%	25%	24%
	N. of Seneca St	13,178	11,393	-14%	13%	17%	22%	27%	21%	13%	16%	24%	25%	23%
	S. of Jackson St	15,603	15,263	-2%	14%	17%	22%	26%	22%	14%	19%	23%	23%	22%
	S. of S Massachusetts St	11,373	10,962	-4%	14%	18%	22%	25%	21%	15%	19%	23%	22%	21%
	N. of Spokane St	11,064	11,024	0%	15%	18%	22%	25%	21%	15%	19%	23%	22%	21%

Table 5-32: Summary of SB Major Corridor Traffic Volumes and Temporal Profile (PM Period)

Facility Name	Section	Volume			Hourly Profile (Observed)					Hourly Profile (Estimated)				
		Observed	Estimated	%Diff	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM
I-5	N. of Ravenna Blvd	21,081	20,673	-2%	24%	23%	19%	16%	18%	23%	22%	18%	18%	19%
	At Ship Canal	27,143	25,431	-6%	23%	22%	19%	17%	19%	21%	22%	19%	19%	19%
	S. of Mercer St	25,671	27,611	8%	24%	21%	18%	17%	20%	19%	22%	21%	20%	17%
	At Seneca St	36,239	31,592	-13%	20%	20%	20%	20%	20%	19%	21%	20%	21%	20%
	S. of Jackson Street	48,275	47,177	-2%	18%	19%	21%	21%	21%	18%	20%	21%	21%	19%
	At S Holgate St	38,791	40,964	6%	19%	20%	21%	21%	20%	17%	19%	22%	21%	21%
	At Spokane Street	31,956	33,841	6%	19%	20%	21%	21%	19%	15%	19%	21%	22%	22%
	At S Oregon Street	46,048	43,627	-5%	18%	20%	21%	21%	19%	16%	19%	21%	22%	22%

Facility Name	Section	Volume			Hourly Profile (Observed)					Hourly Profile (Estimated)				
		Observed	Estimated	%Diff	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM
SR 99	S. of N 46th St Ramps	9,196	9,572	4%	16%	19%	22%	22%	21%	15%	18%	19%	24%	23%
	At Ship Canal	12,316	14,649	19%	16%	19%	23%	22%	21%	14%	16%	21%	25%	24%
	S. of Mercer St	10,957	11,826	8%	16%	19%	24%	22%	19%	16%	18%	21%	22%	23%
	N. of Seneca St	10,896	12,464	14%	18%	22%	22%	19%	19%	14%	16%	23%	23%	23%
	S. of Jackson St	16,150	17,016	5%	15%	19%	22%	22%	22%	15%	19%	22%	22%	22%
	S. of S Massachusetts St	13,327	12,977	-3%	13%	18%	22%	23%	23%	12%	15%	22%	25%	26%
	N. of Spokane St	13,375	12,901	-4%	14%	19%	22%	23%	23%	12%	15%	22%	25%	26%

Table 5-33: DTA Model Travel Patterns by On-Ramp Locations (AM Period)

From	To	%Share Observed	%Share Estimated
SR 99 NB On-Ramp at West Seattle Bridge	South Lake Union & north	24%	35%
	Downtown	76%	65%
SR 99 NB On-Ramp S. of Royal Broughham Way	South Lake Union & north	25%	34%
	Downtown	75%	66%
SR 99 SB Mainline at John St	SODO	21%	39%
	W Seattle/Duwamish & south	79%	61%
SR 99 SB On-Ramp at Elliot Ave	SODO	21%	31%
	W Seattle/Duwamish & south	79%	69%
SR 99 SB On-Ramp at Columbia St	SODO	13%	7%
	W Seattle/Duwamish & south	88%	93%
I-5 Mainline NB S. of S. Spokane St	Green Lake/U District	14%	7%
	South Lake Union	3%	11%
	Downtown/Capitol Hill	67%	52%
	SODO	2%	4%
	West Seattle	15%	27%
I-5 NB On-Ramp from I-90 Westbound	Green Lake/U District	18%	6%
	South Lake Union	14%	12%
	Downtown/Capitol Hill	67%	82%
I-5 SB On-Ramp from NE 45th St	South Lake Union	7%	19%
	Downtown/Capitol Hill	92%	78%
	SODO	0%	1%
I-5 SB On-Ramp from NE 50th St	South Lake Union	6%	28%
	Downtown/Capitol Hill	94%	72%
	SODO	0%	0%

Table 5-34: DTA Model Travel Patterns by On-Ramp Locations (PM Period)

From	To	%Share Observed	%Share Estimated
SR 99 NB On-Ramp at West Seattle Bridge	South Lake Union & north	43%	36%
	Downtown	57%	64%
SR 99 NB On-Ramp S. of Royal Broughham Way	South Lake Union & north	40%	45%
	Downtown	60%	55%
SR 99 SB Mainline at John St	SODO	17%	33%
	W Seattle/Duwamish & south	83%	67%
SR 99 SB On-Ramp at Elliot Ave	SODO	11%	9%
	W Seattle/Duwamish & south	89%	91%
SR 99 SB On-Ramp at Columbia St	SODO	4%	0%
	W Seattle/Duwamish & south	96%	100%
I-5 Mainline NB S. of S. Spokane St	Green Lake/U District	12%	5%
	South Lake Union	3%	15%
	Downtown/Capitol Hill	66%	53%
	SODO	4%	6%
	West Seattle	15%	20%
I-5 NB On-Ramp from I-90 Westbound	Green Lake/U District	20%	5%
	South Lake Union	11%	24%
	Downtown/Capitol Hill	69%	71%
I-5 SB On-Ramp from NE 45th St	South Lake Union	13%	22%
	Downtown/Capitol Hill	84%	77%
	SODO	3%	1%
I-5 SB On-Ramp from NE 50th St	South Lake Union	6%	32%
	Downtown/Capitol Hill	94%	67%
	SODO	0%	1%

Table 5-35: Comparison of NB/EB Average Speeds (AM Period)

			Observed Speed			Estimated Speed		
	From	To	6:00-7:00	7:00-8:00	8:00-9:00	6:00-7:00	7:00-8:00	8:00-9:00
SR 99	Ship Canal /N 36th St	N 45th St	43	45	42	45	44	44
SR 99	6th Ave N	Ship Canal /N 36th St	46	45	46	45	45	45
SR 99	Mercer St	6th Ave N	45	44	43	44	44	44
SR 99	Denny Way	Mercer St	41	42	39	40	39	38
SR 99	Bell St	Denny Way	43	45	43	40	40	40
SR 99	Seneca St	Bell St	46	46	34	41	40	40
SR 99	S Atlantic St	Seneca St	43	37	31	39	32	29
SR 99	W Seattle Br	S Atlantic St	43	37	20	48	33	16
SR 99	**AVG HOURLY**		**44**	**42**	**36**	**43**	**39**	**35**
1st Ave	Wall St	Mercer St	15	16	16	19	18	18
1st Ave	Stewart St	Wall St	16	19	19	24	24	22
1st Ave	Madison St	Stewart St	15	16	15	15	15	15
1st Ave	Columbia St	Madison St	15	16	13	23	23	20
1st Ave	S Royal Brougham Way	Columbia St	17	17	14	23	24	24
1st Ave	S Spokane St	S Royal Brougham Way	24	22	15	23	21	17
1st Ave	**AVG HOURLY**		**16**	**17**	**16**	**22**	**21**	**19**
4th Ave	Battery St	Broad St	17	12	14	17	21	16
4th Ave	Madison St	Battery St	17	16	15	21	21	20
4th Ave	2nd Avenue Ext	Madison St	18	18	15	21	21	21
4th Ave	S Royal Brougham Way	2nd Avenue Ext	21	19	14	17	18	16
4th Ave	S Spokane St	S Royal Brougham Way	22	23	20	24	23	21
4th Ave	**AVG HOURLY**		**20**	**19**	**17**	**21**	**21**	**20**
I-5	NE 40th St	NE 50th St	65	63	59	59	59	59
I-5	SR-520 On-Ramp	NE 40th St	62	62	57	59	57	56
I-5	Mercer St On-ramp	SR-520 On-Ramp	62	60	52	57	54	50
I-5	Denny Way	Mercer St On-Ramp	62	60	57	59	58	58
I-5	Pike St	Denny Way	60	58	64	56	56	53
I-5	Seneca St	Pike St	55	52	48	54	54	54
I-5	James St	Seneca St	51	43	38	51	52	53
I-5	S Holgate St	S Dearborn St	43	29	42	56	57	57
I-5	S Forest St	S Holgate St	40	33	29	52	52	52
I-5	Spokane St/W Seattle Br Exit	S Forest St	39	26	23	27	28	50
I-5	**AVG HOURLY**		**53**	**47**	**46**	**54**	**53**	**54**
Boren Ave	Madison St	Denny Way	15	17	14	19	19	17
Boren Ave	S Jackson St	Madison St	16	15	13	21	21	21
Boren Ave	**AVG HOURLY**		**18**	**18**	**16**	**20**	**20**	**19**
I-90	4th Ave S	6th Ave S	37	34	29	39	36	28
I-90	6th Ave S	On-Ramp from I-5 NB	45	37	28	60	60	59
I-90	**AVG HOURLY**		**41**	**35**	**27**	**52**	**51**	**47**

Table 5-36: Comparison of SB/WB Average Speeds (AM Period)

	From	To	Observed Speed 6:00-7:00	Observed Speed 7:00-8:00	Observed Speed 8:00-9:00	Estimated Speed 6:00-7:00	Estimated Speed 7:00-8:00	Estimated Speed 8:00-9:00
SR 99	N 46th St	Ship Canal/N 36th St	43	40	26	45	44	43
	Ship Canal/N 36th St	6th Ave N	42	38	25	45	44	43
	6th Ave N	Mercer St	41	36	26	44	43	42
	Mercer St	Denny Way	43	34	31	39	38	31
	Denny Way	Bell St	45	42	41	40	40	40
	Bell St	Columbia St	46	36	31	43	43	38
	Columbia St	S Atlantic St	48	42	29	42	41	38
	S Atlantic St	Spokane/W Seattle Bridge	49	48	50	43	43	43
	AVG HOURLY		**45**	**41**	**34**	**43**	**42**	**40**
1st Ave	Denny Way	Battery St	16	15	13	21	20	20
	Battery St	Stewart St	13	14	12	21	21	18
	Stewart St	Madison St	13	13	11	16	16	16
	Madison St	Columbia St	13	12	12	13	11	8
	Columbia St	S Royal Brougham Way	15	13	13	20	20	18
	S Royal Brougham Way	S Spokane St	23	20	21	22	21	20
	AVG HOURLY		**17**	**16**	**16**	**20**	**20**	**19**
4th Ave	2nd Ave Ext	S Royal Brougham Way	21	19	18	15	16	13
	S Royal Brougham Way	S Spokane St	26	23	24	28	27	25
	AVG HOURLY		**25**	**22**	**23**	**25**	**24**	**22**
5th Ave	S Washington St	S Dearborn St	16	16	16	19	16	16
	AVG HOURLY		**16**	**16**	**16**	**19**	**16**	**16**
I-5	N 59th St	N 45th St	61	39	20	59	58	44
	N 45th St	SR 520	58	42	29	58	53	44
	SR 520	E Nelson Pl	61	55	45	58	53	48
	E Nelson Pl	Denny Way	60	48	35	57	45	23
	Denny Way	Pike St	61	45	36	52	22	16
	Pike St	Seneca St	61	50	46	46	21	22
	Seneca St	James St	61	47	48	55	51	39
	S Dearborn St	S Holgate St	61	47	53	58	33	13
	S Holgate St	S Forest St	60	54	57	52	25	17
	S Forest St	S Spokane St	64	60	61	56	42	34
	AVG HOURLY		**61**	**49**	**43**	**56**	**42**	**31**
I-5 Express	N 45th St	SR 520	64	57	36	60	59	60
	SR 520	Mercer St	62	46	24	60	58	43
	Mercer St	Olive Way	58	43	28	59	56	29
	Olive Way	Seneca St	59	46	44	59	30	17
	Seneca St	Yesler Way	61	44	51	31	14	7
	AVG HOURLY		**61**	**49**	**34**	**57**	**48**	**35**
Boren Ave	Denny Way	Madison St	12	12	12	15	14	14
	Madison St	S Jackson St	15	15	15	16	16	13
	AVG HOURLY		**14**	**13**	**14**	**15**	**15**	**14**
I-90	Off-Ramp to Rainier Ave SB	Off-Ramp to I-5 NB	60	38	31	56	54	56
	Off-Ramp to I-5 NB	5th Ave S	58	43	41	52	52	52
	5th Ave S	4th Ave S	37	32	29	28	27	23
	AVG HOURLY		**54**	**39**	**36**	**49**	**48**	**49**

Table 5-37: Comparison of NB/EB Average Speeds (PM Period)

			Observed Speed					Estimated Speed				
	From	To	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00	5:00-6:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00	5:00-6:00
SR 99	Ship Canal /N 36th St	N 45th St	41	39	41	43	42	45	44	44	43	43
	6th Ave N	Ship Canal /N 36th St	42	41	46	44	44	45	45	45	45	45
	Mercer St	6th Ave N	43	39	43	43	42	44	44	44	44	44
	Denny Way	Mercer St	39	41	37	25	17	39	39	38	37	37
	Bell St	Denny Way	41	46	41	31	13	40	40	40	40	40
	Seneca St	Bell St	44	46	46	40	16	43	43	42	42	42
	S Atlantic St	Seneca St	43	42	39	38	33	41	41	39	38	39
	W Seattle Br	S Atlantic St	50	47	50	53	42	48	48	48	48	48
	AVG HOURLY		**44**	**43**	**44**	**42**	**35**	**44**	**44**	**43**	**43**	**43**
1st Ave	Wall St	Mercer St	16	17	18	16	16	20	19	19	19	18
	Stewart St	Wall St	15	17	16	17	16	26	25	24	24	22
	Madison St	Stewart St	14	15	14	14	12	16	16	16	16	16
	Columbia St	Madison St	16	16	17	15	13	17	17	17	16	18
	S Royal Brougham Way	Columbia St	16	14	19	14	14	23	23	21	15	16
	S Spokane St	S Royal Brougham Way	19	22	20	18	18	22	21	18	18	17
	AVG HOURLY		**15**	**16**	**18**	**15**	**15**	**22**	**21**	**19**	**18**	**18**
4th Ave	Battery St	Broad St	16	15	13	15	13	18	18	17	17	17
	Madison St	Battery St	17	18	16	15	13	24	23	23	23	23
	2nd Avenue Ext	Madison St	18	18	17	16	15	21	21	21	20	20
	S Royal Brougham Way	2nd Avenue Ext	20	20	18	19	18	17	17	18	18	19
	S Spokane St	S Royal Brougham Way	23	24	24	23	23	23	22	22	23	23
	AVG HOURLY		**20**	**21**	**19**	**18**	**18**	**22**	**21**	**21**	**21**	**21**
I-5	NE 40th St	NE 50th St	63	61	57	23	30	59	57	55	54	55
	SR-520 On-Ramp	NE 40th St	61	58	56	27	28	59	58	55	51	53
	Mercer St On-ramp	SR-520 On-Ramp	60	57	50	28	23	56	53	52	50	52
	Denny Way	Mercer St On-Ramp	62	58	45	33	19	59	58	58	58	58
	Pike St	Denny Way	62	60	45	38	19	53	51	53	53	52
	Seneca St	Pike St	57	57	45	45	30	56	55	53	53	53
	James St	Seneca St	59	55	47	48	39	57	56	55	56	57
	S Holgate St	James St	58	53	36	28	29	56	54	50	54	54
	S Forest St	S Holgate St	53	50	34	35	31	52	51	51	50	51
	Spokane St/W Seattle Br Exit	S Forest St	57	50	31	36	33	38	17	29	50	55
	AVG HOURLY		**59**	**56**	**44**	**32**	**27**	**54**	**51**	**51**	**52**	**54**
I-5 Express	SR-520 Off-Ramp	NE 45th St	63	63	61	53	53	59	31	31	60	60
	Mercer St On-Ramp	SR-520 Off-Ramp	64	63	61	55	52	60	60	60	60	60
	Olive Way	Mercer St On-Ramp	60	61	53	53	48	59	59	59	59	59
	Seneca St	Olive Way	58	57	47	50	36	60	60	59	59	59
	I-5 Express NB Entrance	Seneca St	55	51	43	39	39	48	42	37	38	38
	AVG HOURLY		**61**	**61**	**56**	**52**	**48**	**58**	**52**	**52**	**58**	**58**
Boren Ave	Madison St	Denny Way	14	16	14	11	13	20	19	19	19	19
	S Jackson St	Madison St	15	14	17	15	14	16	15	15	15	15
	AVG HOURLY		**15**	**15**	**15**	**13**	**13**	**18**	**18**	**17**	**17**	**17**
I-90	4th Ave S	6th Ave S	31	26	24	26	23	35	33	30	13	4
	6th Ave S	On-Ramp from I-5 NB	45	44	38	42	44	60	60	59	60	60
	AVG HOURLY		**40**	**38**	**33**	**37**	**37**	**50**	**49**	**48**	**42**	**38**

Table 5-38: Comparison of SB/WB Average Speeds (PM Period)

			Observed Speed					Estimated Speed				
	From	To	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00	5:00-6:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00	5:00-6:00
SR 99	N 46th St	Ship Canal/N 36th St	42	41	43	41	41	45	45	44	44	44
	Ship Canal/N 36th St	6th Ave N	43	43	43	43	42	45	44	44	44	44
	6th Ave N	Mercer St	43	42	41	31	39	44	44	44	43	43
	Mercer St	Denny Way	39	40	34	18	26	39	39	39	39	38
	Denny Way	Bell St	41	43	32	13	17	40	40	40	40	40
	Bell St	Columbia St	41	43	19	11	10	43	42	27	17	12
	Columbia St	S Atlantic St	41	37	32	29	28	41	40	39	39	39
	S Atlantic St	Spokane/W Seattle Bridge	49	50	50	48	51	43	43	43	43	43
	AVG HOURLY		**43**	**43**	**39**	**32**	**35**	**43**	**42**	**40**	**38**	**38**
1st Ave	Denny Way	Battery St	13	17	14	13	16	28	27	27	25	25
	Battery St	Stewart St	13	14	13	14	13	19	20	19	17	18
	Stewart St	Madison St	13	12	12	11	9	16	15	16	16	14
	Madison St	Columbia St	14	14	14	9	8	18	14	4	2	1
	Columbia St	S Royal Brougham Way	15	16	13	13	11	19	18	18	17	17
	S Royal Brougham Way	S Spokane St	22	22	21	19	18	21	21	20	19	18
	AVG HOURLY		**17**	**17**	**16**	**15**	**14**	**21**	**20**	**19**	**18**	**17**
4th Ave	2nd Ave Ext	S Royal Brougham Way	22	22	23	23	21	16	16	13	13	12
	S Royal Brougham Way	S Spokane St	23	22	23	23	22	26	27	26	25	24
	AVG HOURLY		**22**	**22**	**23**	**23**	**22**	**24**	**24**	**23**	**22**	**21**
5th Ave	S Washington St	S Dearborn St	16	17	15	16	16	20	18	16	16	15
	AVG HOURLY		**16**	**17**	**15**	**16**	**16**	**20**	**18**	**16**	**16**	**15**
I-5	N 59th St	N 45th St	45	30	13	10	13	59	60	60	60	60
	N 45th St	SR 520	41	26	15	12	15	57	56	59	59	58
	SR 520	E Nelson Pl	40	23	12	11	13	57	56	58	57	49
	E Nelson Pl	Denny Way	33	23	19	18	19	55	55	34	17	9
	Denny Way	Pike St	33	28	24	23	24	42	40	14	11	11
	Pike St	Seneca St	47	42	40	35	37	33	33	18	18	17
	Seneca St	James St	50	48	45	38	42	54	54	53	50	37
	James St	S Holgate St	56	50	45	39	42	59	59	59	45	20
	S Holgate St	S Forest St	57	52	50	50	49	55	53	35	22	21
	S Forest St	S Spokane St	59	59	58	58	58	56	54	46	34	34
	AVG HOURLY		**46**	**37**	**30**	**28**	**30**	**55**	**54**	**48**	**41**	**34**
Boren Ave	Denny Way	Madison St	13	13	14	14	13	13	13	13	12	11
	Madison St	S Jackson St	14	16	15	13	14	16	16	15	14	6
	AVG HOURLY		**14**	**15**	**14**	**14**	**13**	**15**	**14**	**14**	**13**	**9**
I-90	Off-Ramp to Rainier Ave SB	Off-Ramp to I-5 NB	59	51	36	50	47	59	59	59	59	59
	Off-Ramp to I-5 NB	5th Ave S	59	49	36	43	43	53	53	53	53	53
	5th Ave S	4th Ave S	29	31	31	33	34	28	26	24	23	23
	AVG HOURLY		**53**	**46**	**35**	**43**	**42**	**51**	**50**	**50**	**50**	**50**

5.6 FUTURE YEAR MODEL DEVELOPMENT

Once the 2015 regional model and DTA model achieved acceptable calibration of existing conditions, the future year models were developed. Using the model that was calibrated to the observed 2015 conditions, the travel patterns for the near-term horizon year 2020 and long-term year 2040 were estimated and provided via subarea extraction for use in estimating the traffic and revenue forecasts in the subsequent DTA modeling process.

5.6.1 MODEL INPUT ASSUMPTIONS

The PSRC trip-based model that underwent several refinements in the model calibration effort was used to estimate the regional travel patterns that formed the basis for the SR 99 T&R forecasts. For the horizon year forecasts, the model inputs were updated to include the following information:

- Updated socioeconomic estimates for year 2020 and 2040
- Updated highway and transit networks reflecting currently anticipated improvements

5.6.1.1 Future Year Socioeconomic Assumptions

As detailed in Chapter 4 of this report, the future year 2020 and 2040 socio-economic data (SED) forecasts were estimated by BERK Consulting. BERK conducted an independent review of available regional and subarea land use forecast products for the Central Puget Sound region, that included several sources. Those sources include PSRC's 2015 Regional Macroeconomic Forecast and the Estimated Growth Capacity by Parcel and Land Use Vision Forecast (LUV) Version 1.0. Based on this review, necessary adjustments were made to develop revised forecast data estimates that are suitable for the development of investment grade traffic and revenue forecasts. The base and future year estimates for total households are summarized with corresponding compound annual growth rates (CAGR) in **Table 5-39**, while the corresponding comparisons for total employment are summarized in **Table 5-40**.

Table 5-39: Summary of Total Households

County	Total Households			CAGR	
	2015	2020	2040	2015-20	2020-40
King	855,382	931,987	1,101,613	1.7%	0.8%
Kitsap	107,124	111,575	143,472	0.8%	1.3%
Pierce	326,829	355,349	460,457	1.7%	1.3%
Snohomish	287,827	316,722	404,516	1.9%	1.2%
Total	1,577,162	1,715,632	2,110,058	1.7%	1.0%

Table 5-40: Summary of Total Employment

County	Total Employment			CAGR	
	2015	2020	2040	2015-20	2020-40
King	1,389,503	1,463,676	1,886,067	1.0%	1.3%
Kitsap	103,946	107,621	137,257	0.7%	1.2%
Pierce	364,102	376,181	503,293	0.7%	1.5%
Snohomish	328,174	343,110	457,274	0.9%	1.4%
Total	2,185,725	2,290,588	2,983,891	0.9%	1.3%

5.6.1.2 Highway and Transit Networks

PSRC provided two model year scenarios as part of the official v4.03 model release, including the 2010 base year and 2040 long-range forecast. As part of the future year model network preparation effort, the 2040 PSRC model highway and transit networks were reviewed in conjunction with a list of relevant projects in PSRC's 2040 regional transportation plan (RTP).

Based on this review, a total of 12 funded or conditionally-funded future year highway and transit projects were identified with corresponding completion years between 2017 and 2040. These projects have been incorporated into the PSRC 2040 network and are consistent with the project descriptions. In addition, a total of 37 relevant unprogrammed/candidate projects identified from the transportation plan were also incorporated into the 2040 PSRC model network. The projects that were deemed significant and relevant for this analysis included:

- 6 projects relating to conversion of existing HOV lanes to HOT facilities on I-5, I-90 and SR 520;
- 15 projects directly relating to improvements along I-405 corridor, and;
- An additional travel lane on I-5 northbound direction between Seneca to Mercer St.

The project team finalized the 2040 background network assumptions by adopting the PSRC model networks, with the exclusion of HOT-lane conversions on I-5, I-90 and SR 520 as directed by WSDOT. For the near-term 2020 horizon year, the relevant funded or conditionally-funded future year highway and transit projects were identified and incorporated into the 2015 base year model network to create the final 2020 networks.

For both year 2020 and 2040, the network assumptions related to the SR 99 Tunnel Project include:

- A 2-mile long SR 99 toll tunnel with northern access at Mercer St and southern access at S. Dearborn St;
- Other related roadway projects including surface street connections in the vicinity of the northern and southern portals as part of the Alaskan Way Viaduct Replacement project;
- A new Alaskan Way and surface street along the waterfront that connects SR 99 to downtown.

5.6.2 MODEL RESULTS

The total person trips produced by the regional TDM for year 2020 and 2040 are summarized at a county level in **Table 5-41**, along with the base year estimates for comparison purpose. As noted

in the table, the CAGR are comparable with the growth in total households for corresponding periods. Similarly, the commercial vehicle trips are also summarized in **Table 5-42** for individual model years. As anticipated, the growth in commercial vehicle traffic correspond well with the growth in total employment.

The daily person trip mode shares as estimated by the regional TDM are summarized in **Table 5-44**. At the regional level, a gradual increase in non-private auto modes (i.e. transit and walk/bike) is observed from 2015 to 2040. Focusing on the growth of traffic pertinent to the study area, the mode shares for daily person trips for the Seattle CBD follow a similar trend with the decreasing usage of private vehicles. However, within the CBD, the trend is more accelerated, possibly due to the higher percentage of short distance trips for areas with higher population and employment density.

Table 5-41: Summary of Regional Daily Total Person Trip End Production

County	Person Trips			CAGR	
	2015	2020	2040	2015-20	2020-40
King	8,414,683	9,160,834	10,891,212	1.7%	0.9%
Kitsap	1,013,745	1,070,245	1,375,983	1.1%	1.3%
Pierce	3,158,982	3,441,566	4,469,016	1.7%	1.3%
Snohomish	2,832,557	3,149,145	4,088,301	2.1%	1.3%
Total	15,419,967	16,821,790	20,824,512	1.8%	1.1%

Table 5-42: Summary of Regional Daily Total Commercial Trip End Production

County	Commercial Vehicle Trips			CAGR	
	2015	2020	2040	2015-20	2020-40
King	282,599	302,038	372,274	1.3%	1.1%
Kitsap	22,875	23,883	30,352	0.9%	1.2%
Pierce	77,022	80,453	105,260	0.9%	1.4%
Snohomish	77,725	81,203	102,802	0.9%	1.2%
Total	460,221	487,577	610,687	1.2%	1.1%

Table 5-43: Daily Person Trip Mode Shares

Mode	2015		2020		2040	
	Regional	CBD	Regional	CBD	Regional	CBD
SOV	6,187,610	158,820	6,729,060	161,120	7,792,890	172,520
HOV (2+)	6,297,590	229,060	6,849,000	231,650	8,464,620	259,400
Transit	555,020	107,060	601,630	112,090	881,030	133,660
Walk/Bike	1,846,090	207,640	2,057,840	243,630	2,824,370	338,880

Table 5-44: Daily Person Trip Mode Shares (Percentages)

Mode	2015		2020		2040	
	Regional	CBD	Regional	CBD	Regional	CBD
SOV	41.6%	22.6%	41.4%	21.5%	39.0%	19.1%
HOV (2+)	42.3%	32.6%	42.2%	30.9%	42.5%	28.7%
Transit	3.7%	15.2%	3.7%	15.0%	4.4%	14.8%
Walk/Bike	12.4%	29.6%	12.7%	32.6%	14.1%	37.4%

The daily vehicle screenline traffic in the detailed study area is summarized in **Table 5-45**. As discussed above, the growth in vehicular traffic for the study area should be more moderate in the future compared to the regional level, as the growth in traffic for the primary study area would be suppressed by the mode shifts away from vehicular traffic in the CBD area. The increased level of annual growth in the longer-term future between year 2020 and 2040 may indicate growth in external-external 'through' traffic movements facilitated by the highway network improvements within the Puget Sound region not directly produced or attracted to the study area. In addition with more growth in both employment and housing in the CBD, an increase in walking and biking trips occurs.

Table 5-45: Summary of N-S Daily Vehicle Screenline Traffic

Scrl Code	Screenline Name	Model Estimated Traffic						CAGR			
		2015		2020		2040		2015-20		2020-40	
		NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
NS-1	Ship Canal	244,947	246,419	250,322	254,540	266,218	271,856	0.4%	0.7%	1.2%	1.3%
NS-2	S. of Mercer St	230,399	204,999	268,749	243,848	269,972	253,218	3.1%	3.5%	0.1%	0.8%
NS-3	N. of Seneca St	217,350	214,908	226,092	222,202	244,658	240,773	0.8%	0.7%	1.6%	1.6%
NS-4	S. of S Jackson St	215,657	221,915	234,243	229,993	250,502	242,543	1.7%	0.7%	1.4%	1.1%
NS-5	S. of S Massachusetts St	194,180	187,191	193,384	193,045	206,129	197,065	-0.1%	0.6%	1.3%	0.4%
NS-6	N. of Spokane St	173,055	160,212	172,339	166,039	180,967	167,324	-0.1%	0.7%	1.0%	0.2%

As described earlier in this chapter, a subarea extraction procedure was utilized to obtain the vehicle demand matrices traversing the DTA model subarea. The relevant time period demand matrices for the subarea extracted from the regional TDM are summarized in **Table 5-46**, with the annual growth between respective model years summarized in **Table 5-47**. The growth trends are considered to be more representative of the local traffic growth within the study area where growth in vehicle trips is offset by substantial shifts from private vehicular travel modes.

While the standard vehicle modes are retained from the base year DTA model, the trip purpose stratification for private vehicle modes are also maintained for the required purposes used in the toll diversion modeling, which are defined as:

- Home-Based Work (HBW)
- Home-Based Other (HBO)—including Home-Based College, Home-Based School, Home-Based Shopping and Home-Based Other trip purposes, and;
- Non-Home-Based (NHB)—including Non-Home-Based Work and Non-Home-Based Other trip purposes.

Prior to proceeding with the DTA modeling effort, the adjustment matrices (or 'delta trip' matrices) to the regional TDM traversal matrices were applied to the initial time period matrices

to create the “final” trip matrices. The delta trip matrices were calculated as the differences between the “initial” base year traversal matrices and the refined trip matrices modified from the initial matrices as part of the DTA model calibration effort. The delta trip matrices are maintained in origin-destination format with unique values specified for individual zonal pairs. The final trips for year 2020 and 2040 and the percentage difference to the initial trips are summarized in **Table 5-48**, showing nominal differences in magnitude, which are of the level of localized refinements in the study area.

Table 5-46: Summary of Subarea Traversal Demand by Vehicle Class

Vehicle Class	AM (6:00 to 9:00)			Mid-Day (9:00 to 3:00)			PM (3:00 to 6:00)		
	2015	2020	2040	2015	2020	2040	2015	2020	2040
SOV	218,737	228,032	236,858	415,062	426,274	437,821	243,309	251,525	261,310
HOV2	36,737	38,616	44,080	90,375	92,342	101,646	67,111	69,097	78,039
HOV3+	17,265	18,168	21,821	48,196	49,333	55,769	33,119	34,139	40,127
Light Truck	21,905	23,017	27,921	39,007	41,185	49,816	27,009	28,305	34,420
Medium Truck	5,780	5,987	7,380	11,612	12,159	14,986	5,649	5,855	7,234
Heavy Truck	5,711	6,140	7,477	12,770	13,898	16,988	5,140	5,541	6,744
Total	306,134	319,960	345,537	617,021	635,192	677,026	381,338	394,463	427,873

Table 5-47: Growth in Subarea Vehicle Demand (CAGR)

Vehicle Class	AM		MD		PM	
	2015-20	2020-40	2015-20	2020-40	2015-20	2020-40
SOV	0.8%	0.2%	0.5%	0.1%	0.7%	0.2%
HOV2	1.0%	0.7%	0.4%	0.5%	0.6%	0.6%
HOV3+	1.0%	0.9%	0.5%	0.6%	0.6%	0.8%
Light Truck	1.0%	1.0%	1.1%	1.0%	0.9%	1.0%
Medium Truck	0.7%	1.1%	0.9%	1.1%	0.7%	1.1%
Heavy Truck	1.5%	1.0%	1.7%	1.0%	1.5%	1.0%
Total	0.9%	0.4%	0.6%	0.3%	0.7%	0.4%

Table 5-48: Summary of Subarea Traversal Demand by Vehicle Class with Calibration Adj.

Vehicle Class	AM (6:00 to 9:00)				Mid-Day (9:00 to 3:00)				PM (3:00 to 6:00)			
	2020		2040		2020		2040		2020		2040	
	Trips	%Diff	Trips	%Diff	Trips	%Diff	Trips	%Diff	Trips	%Diff	Trips	%Diff
SOV	229,619	0.7%	238,603	0.7%	432,616	1.5%	444,601	1.5%	252,127	0.2%	261,855	0.2%
HOV2	37,910	-1.8%	43,392	-1.6%	93,493	1.2%	102,667	1.0%	67,610	-2.2%	77,084	-1.2%
HOV3+	17,975	-1.1%	21,526	-1.4%	49,783	0.9%	56,119	0.6%	33,833	-0.9%	39,615	-1.3%
Light Truck	23,656	2.8%	28,578	2.4%	42,826	4.0%	51,503	3.4%	28,410	0.4%	34,535	0.3%
Medium Truck	6,156	2.8%	7,560	2.4%	12,823	5.5%	15,665	4.5%	6,086	3.9%	7,479	3.4%
Heavy Truck	6,381	3.9%	7,727	3.3%	14,578	4.9%	17,720	4.3%	5,744	3.7%	6,956	3.1%
Total	321,697	0.5%	347,386	0.5%	646,120	1.7%	688,274	1.7%	393,810	-0.2%	427,523	-0.1%

5.7 FUTURE SUBAREA DYNAMIC TRAFFIC ASSIGNMENT MODEL

Model enhancement was performed to incorporate toll diversion modeling methodology to the DTA model. The relevant model input assumptions and corresponding results are summarized and discussed in the following sections.

5.7.1 MODEL INPUT ASSUMPTIONS

The DTA model assumptions and corresponding refinement from 2015 base year are summarized in this section, including:

- Future year travel demand matrices
- Highway and transit networks
- Toll Diversion modeling parameters

5.7.1.1 Future year travel demand matrices

This section documents the establishment of future year trip matrices for DTA for the toll diversion modeling process. The specification of the travel demand and vehicle classes across different modeling platforms are summarized in **Table 5-49**, where the additional demand classes and appropriate toll choice type stratification required by toll diversion modeling are shown.

Table 5-49: Future Year Model Demand Classes Specification

<table>
<tr><th colspan="2">Regional Model</th><th colspan="3">Toll Diversion Model</th><th colspan="2">DTA Assignment</th></tr>
<tr><th>Vehicle Class</th><th>Trip Purpose</th><th>Vehicle Class</th><th>Trip Purpose</th><th>Toll Choice</th><th>Vehicle Class</th><th>Toll Choice</th></tr>
<tr><td>SOV</td><td>HBW</td><td>SOV</td><td>HBW</td><td>Free/ETC/PBM</td><td rowspan="4">LOV
(SOV + Light Truck)</td><td rowspan="4">Free/ETC/PBM</td></tr>
<tr><td>SOV</td><td>HBO</td><td>SOV</td><td>HBO</td><td>Free/ETC/PBM</td></tr>
<tr><td>SOV</td><td>NHB</td><td>SOV</td><td>NHB</td><td>Free/ETC/PBM</td></tr>
<tr><td colspan="2">Light Truck</td><td colspan="2">Light Truck</td><td>Free/ETC/PBM</td></tr>
<tr><td>HOV2</td><td>HBW</td><td>HOV2</td><td>HBW</td><td>Free/ETC/PBM</td><td rowspan="6">HOV
(HOV2 + HOV3+)</td><td rowspan="6">Free/ETC/PBM</td></tr>
<tr><td>HOV2</td><td>HBO</td><td>HOV2</td><td>HBO</td><td>Free/ETC/PBM</td></tr>
<tr><td>HOV2</td><td>NHB</td><td>HOV2</td><td>NHB</td><td>Free/ETC/PBM</td></tr>
<tr><td>HOV3</td><td>HBW</td><td>HOV3</td><td>HBW</td><td>Free/ETC/PBM</td></tr>
<tr><td>HOV3</td><td>HBO</td><td>HOV3</td><td>HBO</td><td>Free/ETC/PBM</td></tr>
<tr><td>HOV3</td><td>NHB</td><td>HOV3</td><td>NHB</td><td>Free/ETC/PBM</td></tr>
<tr><td colspan="2">Medium Truck</td><td colspan="2">Medium Truck</td><td>Free/ETC/PBM</td><td>Medium Truck</td><td>Free/ETC/PBM</td></tr>
<tr><td colspan="2">Heavy Truck</td><td colspan="2">Heavy Truck</td><td>Free/ETC/PBM</td><td>Heavy Truck</td><td>Free/ETC/PBM</td></tr>
</table>

In addition to the three travel demand purposes for the private vehicle modes as described in the earlier section, each trip purpose is stratified by toll choice type for each vehicle type group. The process to allocate vehicle trips into corresponding toll choice types will be discussed later in this document.

1. Free – Trips that do not use SR 99
2. ETC – toll road users that utilize a transponder (i.e. Good-to-Go!) as the payment method
3. PBM – toll road users that use pay-by-mail as a payment method, subject to $2 surcharge

The outputs from the toll diversion model include 36 demand matrices. Due to the limitation of demand classes in Dynameq, the initial six vehicle classes are consolidated into the following vehicle classes:

- Low Occupancy Vehicles (LOV)—including SOV and Light Trucks
- High Occupancy Vehicles (HOV)—including HOV2 and HOV3+
- Medium Trucks
- Heavy Trucks

5.7.1.2 Highway and Transit Networks

The year 2020 and 2040 DTA model networks were updated accordingly from 2015 base year version. The future year DTA model networks include the SR 99 toll tunnel with other related roadway surface street projects in the northern and southern portals, as well as the new Alaskan Way and surface street along the waterfront. As discussed in the regional TDM network assumptions earlier in the document, the list of future year background projects relevant to the DTA subarea network was sourced from PSRC's 2040 RTP. The notable background projects include:

- SR 520 Bridge Replacement and HOV Program
- I-90 - Two-Way Transit and HOV Operations
- I-5 - NB Seneca to SR 520 - Mobility Improvements

5.7.1.3 Toll Diversion Modeling Parameters

The toll diversion model adopted for this project is based on the process initially developed in 2001 for the Central Texas Turnpike System (CTTS) in Austin, Texas. This model had successfully predicted traffic and revenue for several new toll roads and was recently recalibrated to replicate current conditions. The diversion model is essentially a logit-based route choice model embedded within a DTA assignment routine to allocate traffic into appropriate toll-usage type. The structure of the toll diversion model is defined as follows:

Toll Share = (1 / (1+ e^U))

Where:

- Toll Share = Probability of selecting a toll road
- e = Natural Logarithm
  U = "Utility" of Toll Route: a * (TimeTR-TimeFR) + b * Cost + CTR + CETC
- TimeTR = Toll road travel time in minutes
- TimeFR = Nontoll road travel time in minutes
- Cost = Toll in dollars
- CTR = Constant for toll road bias
- CETC = Constant for ETC bias
- a,b = Coefficients

The coefficients of the logit equations were revised from the Austin model to reflect the changes in the composition of trip purposes provided in the PSRC regional model as well as differences in the household income for Austin and for Seattle. The coefficients and constants, along with key relationships are shown in **Table 5-50**. Note that the constant terms (TOLL & ETC) represent negative and positive biases that influence toll choice. The 'Toll' bias term reflects a traveler's general bias against toll roads, while the 'ETC' bias term reflects the positive bias associated with both the ease of payment and delayed payment effect, where the cost of the toll is not fully recognized at the time of the trip. Both terms are translated into equivalent minutes to better comprehend the influence of the bias terms, as shown in the last two columns of the table. Note that both transponder patrons and PBM patrons are subject to the bias terms.

Table 5-50: Toll Diversion Model Parameters

Year	2014
Median Household Income	$68,969

Trip Purpose	Occupancy	"Alpha" Time (min)	"Beta" Cost ($)	VOT ($ / hr)	Bias Terms			
					Toll	ETC	Toll (min)	ETC (min)
HBW	SOV	0.1053	0.3178	$ 19.88	0.0000	-0.2960	0.0	-2.8
	HOV-2	0.1053	0.2764	$ 22.86	0.0000	-0.2960	0.0	-2.8
	HOV-3+	0.1053	0.2211	$ 28.58	0.0000	-0.2960	0.0	-2.8
HBO	SOV	0.0537	0.2013	$ 16.02	0.1690	-0.2208	3.1	-4.1
	HOV-2	0.0537	0.1751	$ 18.42	0.1690	-0.2208	3.1	-4.1
	HOV-3+	0.0537	0.1401	$ 23.03	0.1690	-0.2208	3.1	-4.1
NHB	SOV	0.1051	0.3811	$ 16.54	0.0000	-0.3400	0.0	-2.4
	HOV-2	0.1051	0.3314	$ 19.02	0.0000	-0.3400	0.0	-2.4
	HOV-3+	0.1051	0.2651	$ 23.78	0.0000	-0.3400	0.0	-2.4
Light Truck		0.1051	0.3811	$ 16.54	0.0000	-0.3400	0.0	-2.4
Medium Truck		0.0575	0.1328	$ 25.98	0.3375	0.0000	5.9	0.0
Heavy Truck		0.0575	0.0596	$ 57.87	0.3375	0.0000	5.9	0.0

6.0 TRAFFIC AND GROSS TOLL REVENUE FORECAST

6.1 TOLL SCENARIO ASSUMPTIONS

Four potential toll scenarios were initially identified for the investment grade traffic and gross potential revenue analysis. While some of them bear resemblance to one or more of the previous formal ACTT scenarios or informal WSDOT scenarios, the investment grade toll scenarios have been structured to differ only by their toll schedules while holding other factors such as truck toll multipliers and hours/days of tolling constant. This was done to isolate differences in traffic and revenue across the scenarios as attributable only to changes in assumed toll rates.

6.1.1 Common Demand Modeling Toll Assumptions

6.1.1.1 Start Date for Tolling

The base case assumption for tolling start date is March 1, 2019 for IG-0, IG-1, and IG-2. Option A assumes a tolling start date of July 1, 2019. This is assumed to be roughly five months after the tunnel is completed and open for traffic operations.

6.1.1.2 Hours of Tolling

All tolling scenarios assume that tolling will be operational 24 hours per day, seven days per week. Weekday tolls may vary by time of day for the six operational periods as shown in **Table 6-1** below.

Table 6-1: Tolling Periods

<table>
<tr><th>Weekday Period Name</th><th>PSRC Regional Demand Model Periods</th><th>Dynamic Traffic Assignment (DTA) Model Periods</th><th>Operational Periods for Revenue Forecasts</th></tr>
<tr><td>AM Peak</td><td>6am to 9am</td><td>6am to 9am</td><td>6am to 9am</td></tr>
<tr><td>MD Off-Peak</td><td>9am to 3pm</td><td>1pm to 3pm</td><td>9am to 3pm</td></tr>
<tr><td>PM Peak</td><td>3pm to 6pm</td><td>3pm to 6pm</td><td>3pm to 6pm</td></tr>
<tr><td>Evening Off-Peak</td><td>6pm to 10pm</td><td rowspan="3">N/A</td><td>6pm to 11pm</td></tr>
<tr><td rowspan="2">Night/Early Morning Off-Peak</td><td rowspan="2">10pm to 6am</td><td>11pm to 5am</td></tr>
<tr><td>5am to 6am</td></tr>
</table>

6.1.1.3 Weekend Tolling

All of the tolling scenarios include weekend tolling with the common assumption of a $1.00 uniform flat toll. The inclusion of weekend tolls adds revenue; however, because there are no models to simulate weekend travel patterns and traffic conditions, a conservative estimation approach is applied based on empirical toll-free weekend-to-weekday traffic factors and the application of off-peak weekday model diversion factors. The lack of precision of the weekend traffic and revenue forecasts for this effort do not warrant testing small variations in weekend toll assumptions.

6.1.1.4 Value of Time

The Value of Time (VOT) assumptions are consistent, though not identical, with the assumptions used in the prior study and ACTT analysis. The VOT rates were derived by beginning with those used in the SR 520 investment grade traffic and revenue projections and adjusting these rates based on income stratification for potential trips for the SR 99 tunnel. **Table 6-2** summarizes the VOT assumptions by trip type. It should be noted that the values of time are expected to remain constant in real terms, keeping pace with, but not exceeding, the assumed rate of inflation (2.5%).

Table 6-2: Value of Time Assumptions by Trip Purpose and Vehicle Occupancy

Trip Purpose	Occupancy	VOT ($ / hr)
HBW	SOV	$ 19.88
	HOV-2	$ 22.86
	HOV-3+	$ 28.58
HBO	SOV	$ 16.02
	HOV-2	$ 18.42
	HOV-3+	$ 23.03
NHB	SOV	$ 16.54
	HOV-2	$ 19.02
	HOV-3+	$ 23.78
Light Truck		$ 16.54
Medium Truck		$ 25.98
Heavy Truck		$ 57.87

6.1.1.5 Truck Toll Multipliers

The toll traffic modeling tools utilize three vehicle classifications: two-axle autos and small trucks, three-axle medium trucks, and large trucks with four or more axles, including tractor-trailer rigs. With toll rates likely to be set on an axle count basis, the medium and large truck tolls are simulated as factor multiples of the base two-axle toll rates. Once open, the facility will likely adopt a policy where truck toll rates are set based on the number of axles. This policy will cover numerous vehicle classes. In the modeling process, however, limited classes are available, so only medium and heavy truck classes can be modeled. It is important, therefore, to calculate the average number of axles within these classes and an approximate toll rate for these classes.

To be consistent with truck tolling rates on other regional toll facilities, an analysis was undertaken of transaction data from SR 520 to calculate the average truck toll multiplier for medium and large trucks. Medium trucks are assumed to pay 1.06 times (1.06x) the base two-axle auto toll. Large trucks are assumed to pay an average multiple of 2.09 times (2.09x), which assumes that the average large truck axle count is approximately 4.2 axles among trucks using the SR 99 tunnel. This is slightly lower than the 2.25x and 2.5x factors used in the previous toll studies for the facility.

6.1.2 Gross Revenue Calculation Toll Assumptions

Pay by plate fees and late payment rebilling fees are not included in the gross toll revenue potential calculations; rather, they are captured as revenue adjustments within the net revenue projections.

6.1.2.1 Payment Method Distribution

The Good To Go! prepaid account share of tolled tunnel traffic is assumed to be 75% in the opening year, with the remaining 25% traffic share representing non-account Pay By Mail customers. The Good To Go! prepaid account share is assumed to gradually increase to 85% over a period of 20 years, with non-account Pay By Mail use decreasing to 15%. All toll rates shown herein represent the Good To Go! toll levels for prepaid account customers with transponders in their vehicles.

6.1.2.2 Pay By Mail Increment

For purposes of revenue calculations, customers without a Good To Go! prepaid account are assumed to pay an additional $2.00 per toll trip for the convenience of receiving a bill in the mail. This toll increment assumption is consistent with the toll increment for the SR 520 Bridge and other regional toll facilities. Vehicles in the model that are not equipped with a transponder will see a higher toll rate on the SR 99 and respond to this toll rate when deciding whether or not to utilize the facility.

6.1.3 Scenario-specific Toll Rate Assumptions

The following four toll scenarios vary by their weekday toll schedules from lowest (IG-1) to highest (IG-2). The three IG scenarios assume that tolls will remain fixed through the forecast horizon for purposes of financial planning; there is no toll escalation to keep pace with inflation. The fourth scenario, Option A, assumes 3.0 percent toll escalation (rounded to the nearest nickel) would occur every three years, starting in FY 2023. **Table 6-3** summarizes the assumptions for each toll scenario.

6.1.3.1 IG-0 – Financial Plan

IG-0 assumes a $1.75 base toll during the weekday AM period (6am to 9am), a $1.50 base toll during the weekday early morning, midday, and evening periods (5am to 6am, 9am to 3pm, and 6pm to 11pm), and a $2.50 base toll during the PM peak period (3pm to 6pm). A $1.00 base toll is assumed at all other times of day (11pm to 5am) and all day on weekends. IG-0 assumes no toll escalation over the life of the forecast.

6.1.3.2 IG-1 – Low Diversion

IG-1 assumes a $1.25 base toll during the weekday AM and PM periods (6am to 9am and 3pm to 6pm), a $1.00 base toll at all other times of day (9am to 3pm and 6pm to 5am), and all day on weekends. IG-1 assumes no toll escalation over the life of the forecast.

6.1.3.3 Option A – WSTC Adopted Toll Rates

The toll rates adopted by the Washington State Transportation Commission (WSTC) in the fall of 2018 — referred to herein as Option A — includes a $1.00 minimum toll overnight from 11pm to 6am on weekdays and all day on weekends, a $1.25 shoulder period toll from 6am to 7am, 9am

to 3pm, and 6pm to 11pm on weekdays, a weekday AM peak period toll of $1.50 from 7am to 9am, and a weekday PM peak period toll from 3pm to 6pm. Although only the initial toll rates were adopted by the Commission, in selecting the Option A toll rates, they also assumed 3.0% toll escalation (rounded to the nearest nickel) would occur every three years, starting in FY 2023 (July 1, 2022).

6.1.3.4 IG-2 – Revenue Maximization

IG-2 assumes a $5.80 base toll during the weekday AM period (6am to 9am), a $4.95 base toll during the weekday early morning, midday, and evening periods (5am to 6am, 9am to 3pm, and 6pm to 11pm), and a $6.80 base toll during the PM peak period (3pm to 6pm). A $1.10 base toll is assumed at all other times of day (11pm to 5am) and all day on weekends. Unlike IG-0 and IG-1, IG-2 assumes that tolls will escalate at 2.5 percent over the life of the forecast.

Table 6-3: Toll Scenario Assumptions

Toll Scenario	Toll Rate Schedules*	Truck Toll Multipliers	Payment Method Distribution	Other Toll-Related Fees	Comments
Scenario IG-0 (Financial Plan)	Minimum **$1.00** 11 PM-5 AM Nights & All Day on Weekends Off-Peak **$1.50** 5-6 AM, 9 AM-3 PM, & 6-11 PM Weekdays AM Peak **$1.75** 6-9 AM Weekdays PM Peak **$2.50** 3-6 PM Weekdays	Trucks Pay an Axle Multiplier of the Base 2-axle Auto Toll Medium Trucks = 1.06x the 2-axle Toll on Average Large Trucks = 2.09x the 2-axle Toll on Average	75% Good To Go! Account and 25% Pay By Mail in FY 2020 increasing before leveling off at 85% Good To Go! Account and 15% Pay By Mail in FY 2040	$0.25 Fee for Pay By Plate, applied to 15% of total transactions (17-20% of *Good To Go!* transactions) $5.00 per statement Late Payment Rebilling Fee for all Pay By Mail transactions unpaid after first invoice	Financial Plan toll rates similar to ACTT Scenario 4 and in between preliminary Scenarios C and D; no toll escalation
Scenario IG-1 (Low Diversion)	Minimum **$1.00** 11 PM-5 AM Nights & All Day on Weekends Off-Peak **$1.00** 5-6 AM, 9 AM-3 PM, & 6-11 PM Weekdays AM Peak **$1.25** 6-9 AM Weekdays PM Peak **$1.25** 3-6 PM Weekdays				Low Diversion toll rates same as ACTT Scenario 7 (except no toll escalation); also same as preliminary Scenario A
Option A (Adopted Toll Rates)	Minimum **$1.00** 11 PM-6 AM Nights & All Day on Weekends Off-Peak **$1.25** 6-7 AM, 9 AM-3 PM, & 6-11 PM Weekdays AM Peak **$1.50** 7-9 AM Weekdays PM Peak **$2.25** 3-6 PM Weekdays				Adopted toll rates assume 3% toll increases every 3 years, starting FY 2023 thru FY 2059
Scenario IG-2 (Maximum Revenue)	Minimum **$1.10** in FY 2019 + 2.5% annual escalation | 11 PM-5 AM Nights & All Day on Weekends Off-Peak **$4.95** in FY 2019 + 2.5% annual escalation 5-6 AM, 9 AM-3 PM, & 6-11 PM Weekdays AM Peak **$5.80** in FY 2019 + 2.5% annual escalation 6-9 AM Weekdays PM Peak **$6.80** in FY 2019 + 2.5% annual escalation 3-6 PM Weekdays				Maximum Revenue toll rates higher than the ACTT High Benchmark in FY 2019 and include toll escalation

* Pay By Mail toll rates are $2.00 higher; Scenario IG-2 toll rates for FY 2019 are rounded to the nearest nickel.
Note: All scenarios assume that buses are no longer allowed to use the 3rd Ave tunnel and that the Alaskan Way viaduct has been removed and the surface Alaskan Way is open with all improvements completed.

6.1.4 Demand Modeling and Post Processing

Each of the toll scenarios, plus a toll-free case, were modeled in both the 4k version of the Puget Sound Regional Council (PSRC) regional demand model and the Dynamic Traffic Assignment (DTA) model, the latter of which was developed and refined over 2011-13 for the previous ACTT study and updated as part of this study. The zonal structure of the DTA model was updated to reflect the additional detail of the recently released PSRC 4k model. Software advancements in Dynameq, the platform for the DTA model, have also increased the number of available vehicle classes that can be modeled. Combined with the increased zonal detail, this allows the model to increase the granularity of the analysis with less aggregation of trip types and values of travel times.

6.1.4.1 Weekday Demand Projections

Two forecast years were analyzed: FY 2020 and FY 2040. As detailed in Chapter 4 of this report, an independent land use forecast was developed for incorporation into both modeling platforms for the two forecast years. Future year traffic networks were reviewed and updated accordingly to accurately reflect expectations of transportation capacity in the forecast years.

The DTA model provides simulated toll traffic volumes for the SR 99 tunnel for the three vehicle classes in both travel directions for the two forecast years. Simulation is conducted for a total of eight hours, with three morning hours from 6am to 9am, two midday hours from 1pm to 3pm, and three afternoon hours from 3pm to 6pm. This process yields toll diversion rates for each of the eight hours by three vehicle classes by two travel directions for each of the two forecast years.

The toll results from the regional demand model are reviewed for benchmarking purposes, but do not contribute significantly to the toll traffic forecasts. Rather, the daily toll-free volumes for total vehicles by direction from this model are used as inputs to the toll traffic projections in post processing.

6.1.4.2 24-Hour Weekday Toll Traffic Forecasts

Detailed diurnal traffic data, collected in both directions at the existing SR 99 Battery Street Tunnel as part of the data collection program outlined in Chapter 3, were calculated. These data represent a suitable proxy for the time of day traffic distribution by direction for what in the future will be SR 99 “through trips” served by the new tunnel.

The diurnal distributions noted above are used to distribute the demand model daily toll-free volumes by direction to yield total 24-hour toll-free tunnel volumes for both forecast years. For the toll scenarios, the DTA model diversion rates are then applied to the corresponding toll-free hourly volumes to create hourly toll volumes. For both the toll-free case and the tolled scenarios, vehicle class distribution shares from the DTA model for each scenario are used to subdivide the hourly volumes to yield post-processed hourly volumes.

There is a direct correspondence between diversion rates and hourly volumes for the six hours represented by the AM and PM peak periods. The midday diversion rates by direction are applied to the off-peak daytime and evening hours, with minor adjustments to the two AM shoulder hours. A significant diversion rate is also applied to the night hours from 11 pm to 5 am to represent that even though the toll rate is low, congestion on toll-free routes is minimal.

Figure 6-1 through **Figure 6-12** provides the daily toll volumes by direction and by scenario for the AM, MD, PM, EV, NT, and total daily periods for FY 2020. Similar data for FY 2040 is provided in **Figure 6-13** through **Figure 6-24**.

Figure 6-1: Comparison of Northbound FY 2020 Tunnel Volumes by Toll Scenario (Daily)

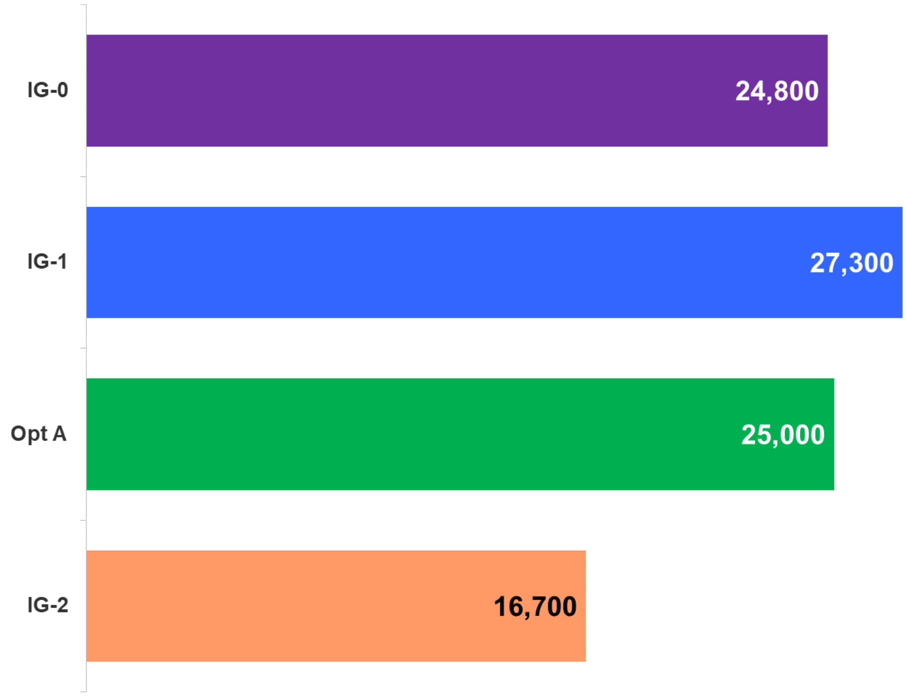


Figure 6-2: Comparison of Northbound FY 2020 Tunnel Volumes by Toll Scenario (6am to 9am)

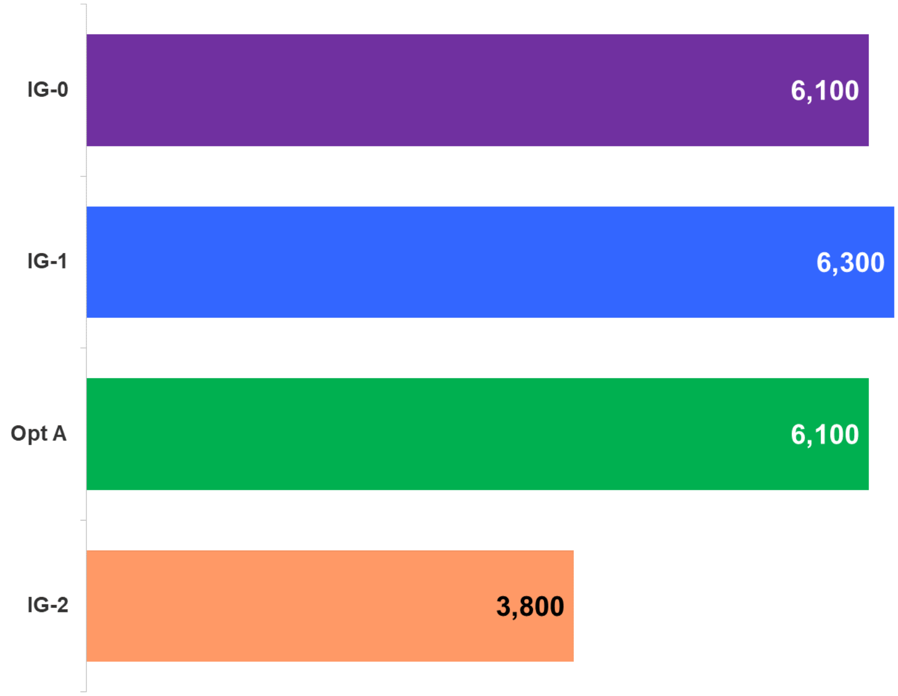


Figure 6-3: Comparison of Northbound FY 2020 Tunnel Volumes by Toll Scenario (9am to 3pm)

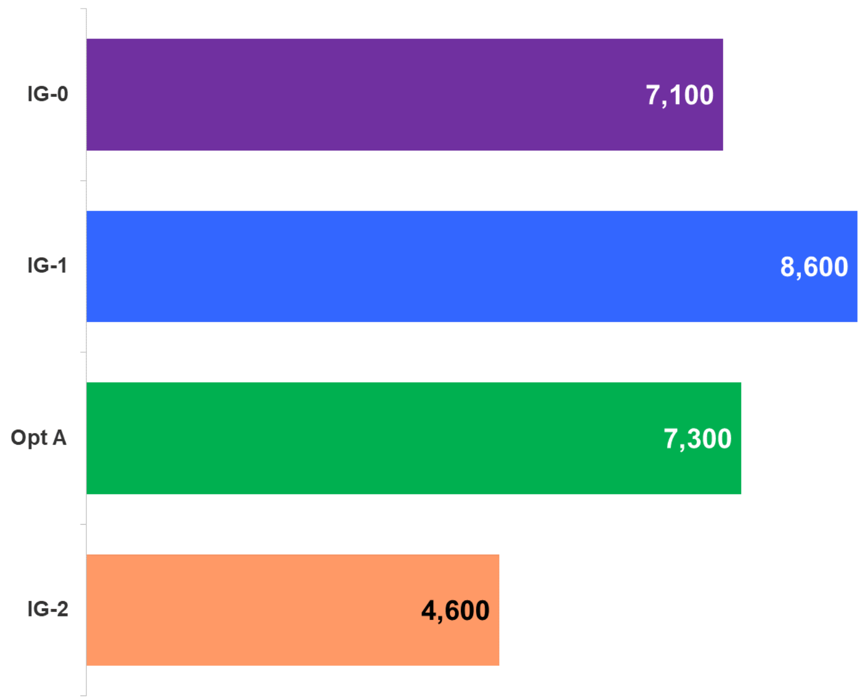


Figure 6-4: Comparison of Northbound FY 2020 Tunnel Volumes by Toll Scenario (3pm to 6pm)

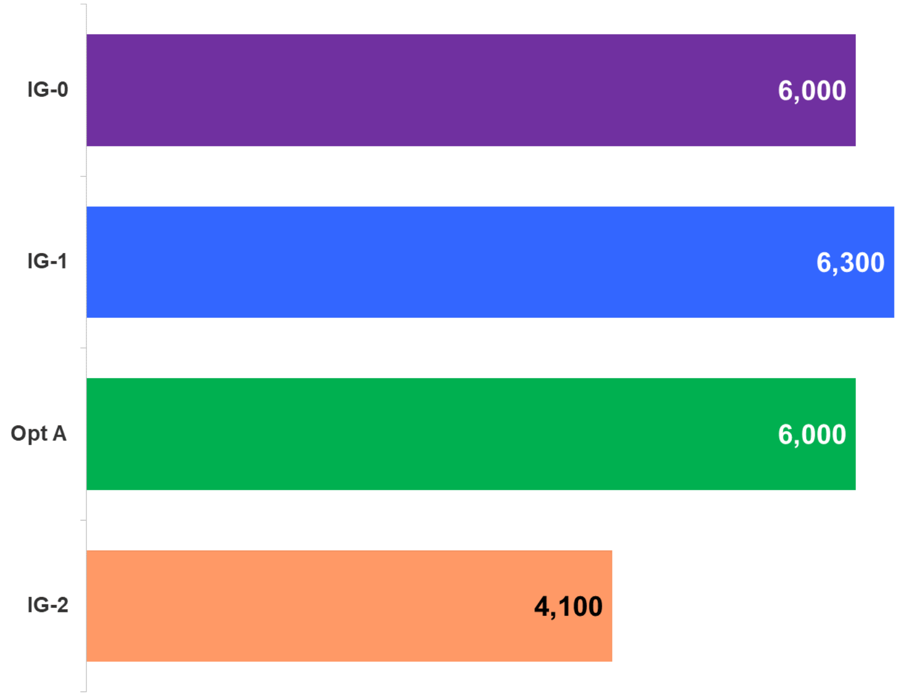


Figure 6-5: Comparison of Northbound FY 2020 Tunnel Volumes by Toll Scenario (6pm to 11pm)

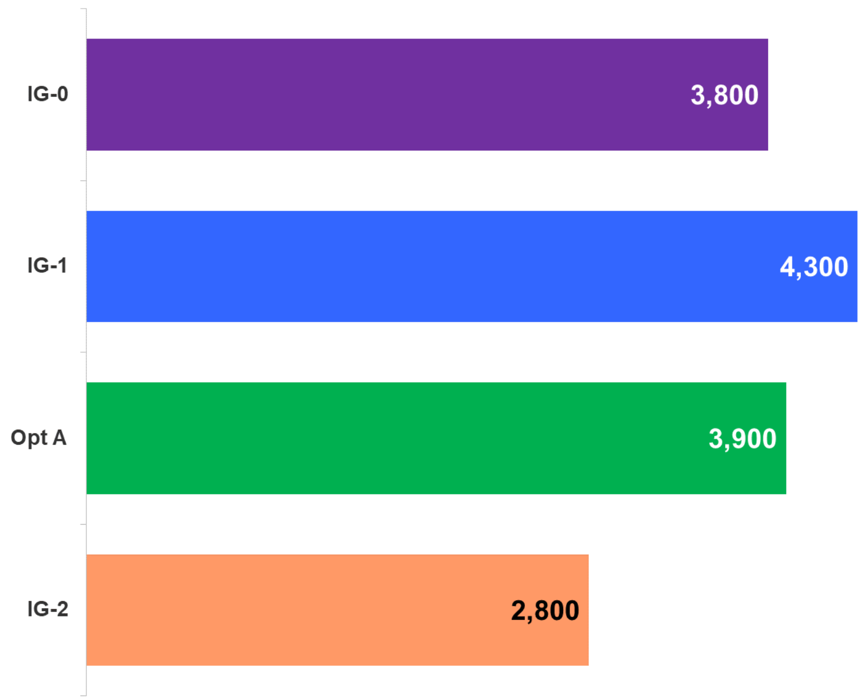


Figure 6-6: Comparison of Northbound FY 2020 Tunnel Volumes by Toll Scenario (11pm to 6am)

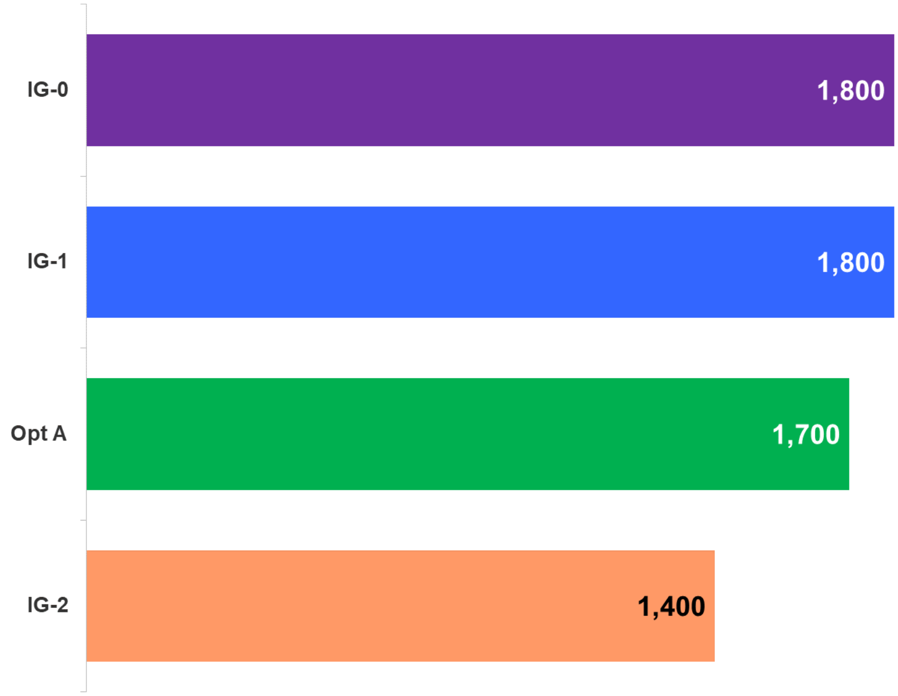


Figure 6-7: Comparison of Southbound FY 2020 Tunnel Volumes by Toll Scenario (Daily)

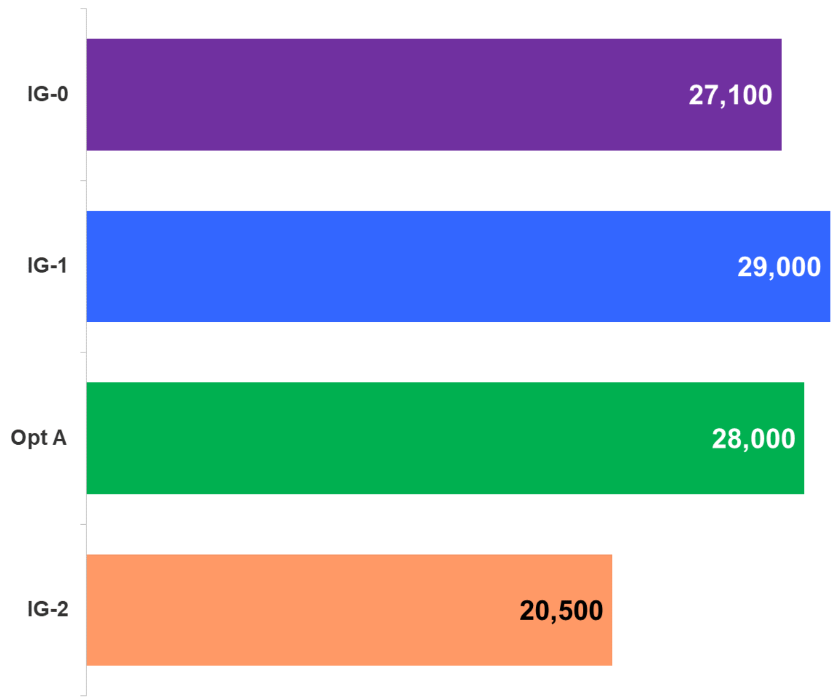


Figure 6-8: Comparison of Southbound FY 2020 Tunnel Volumes by Toll Scenario (6am to 9am)

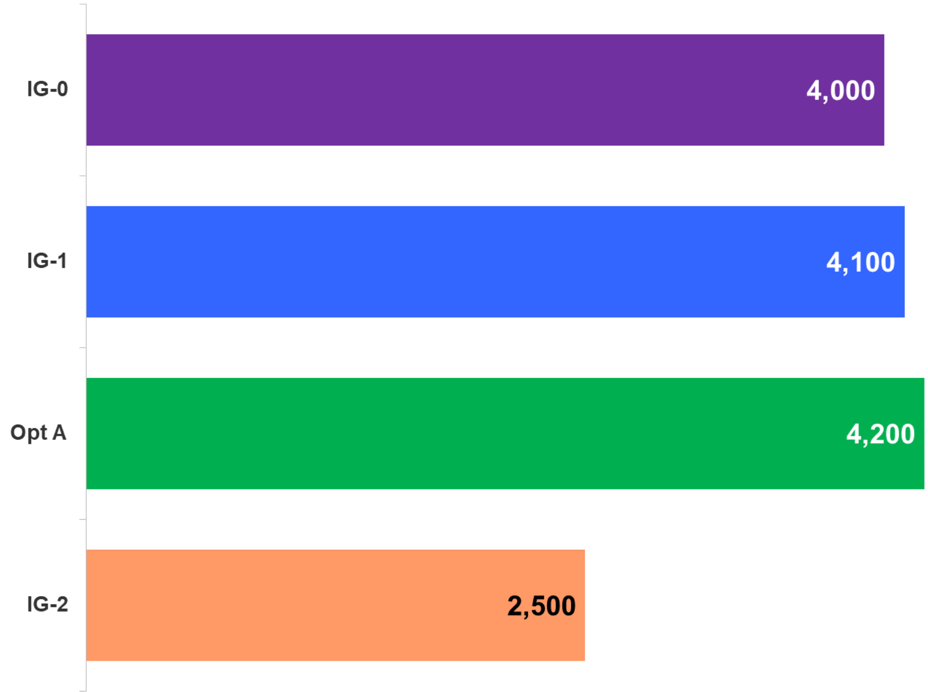


Figure 6-9: Comparison of Southbound FY 2020 Tunnel Volumes by Toll Scenario (9am to 3pm)

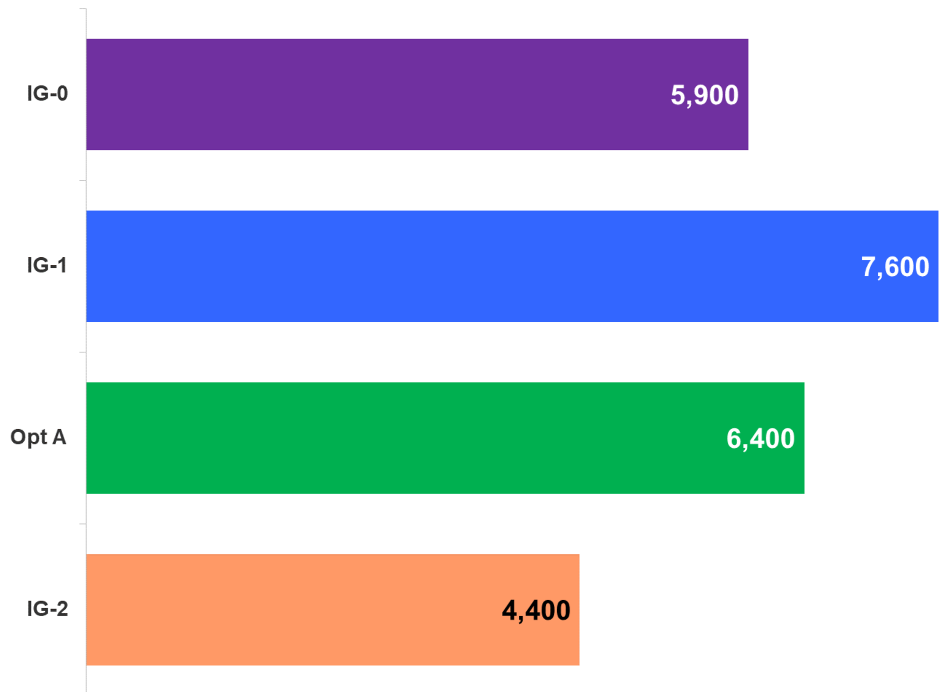


Figure 6-10: Comparison of Southbound FY 2020 Tunnel Volumes by Toll Scenario (3pm to 6pm)

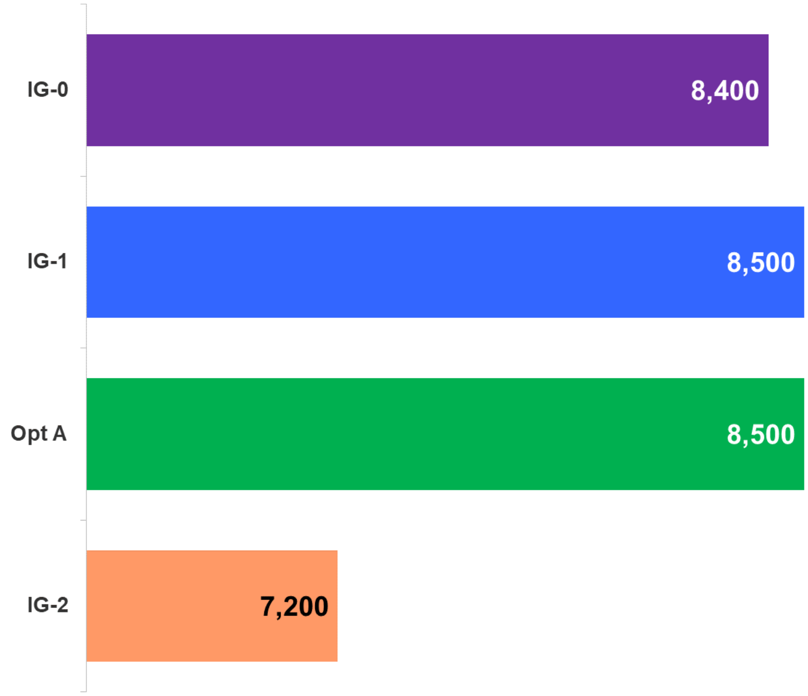


Figure 6-11: Comparison of Southbound FY 2020 Tunnel Volumes by Toll Scenario (6pm to 11pm)

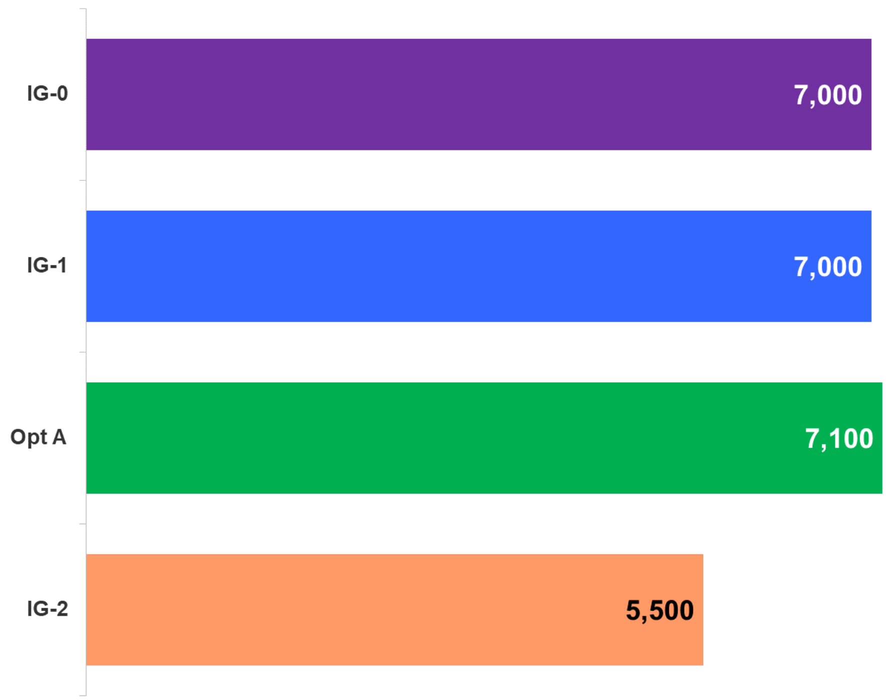


Figure 6-12: Comparison of Southbound FY 2020 Tunnel Volumes by Toll Scenario (11pm to 6am)

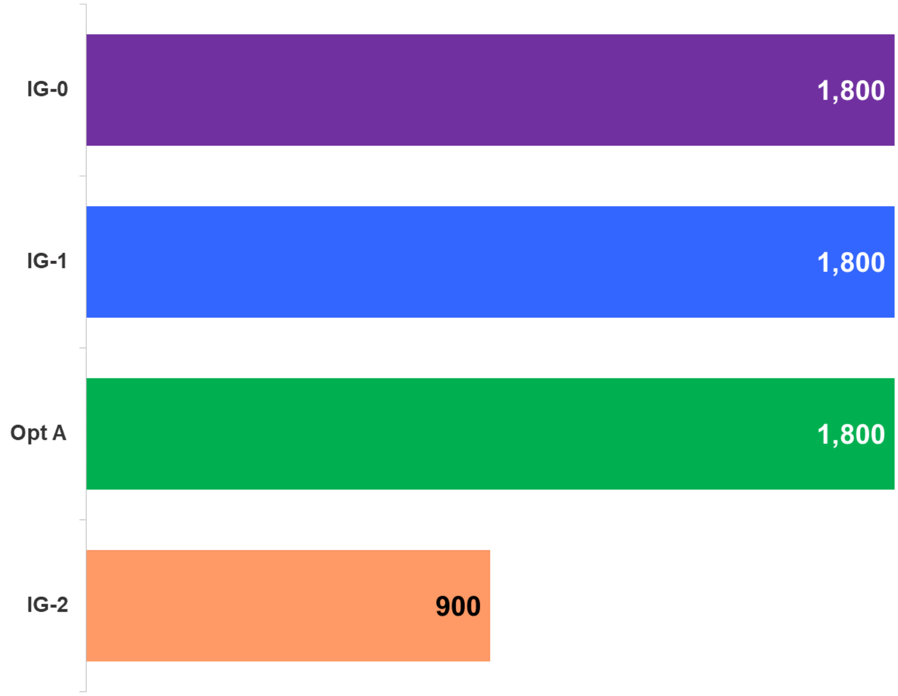


Figure 6-13: Comparison of Northbound FY 2040 Tunnel Volumes by Toll Scenario (Daily)

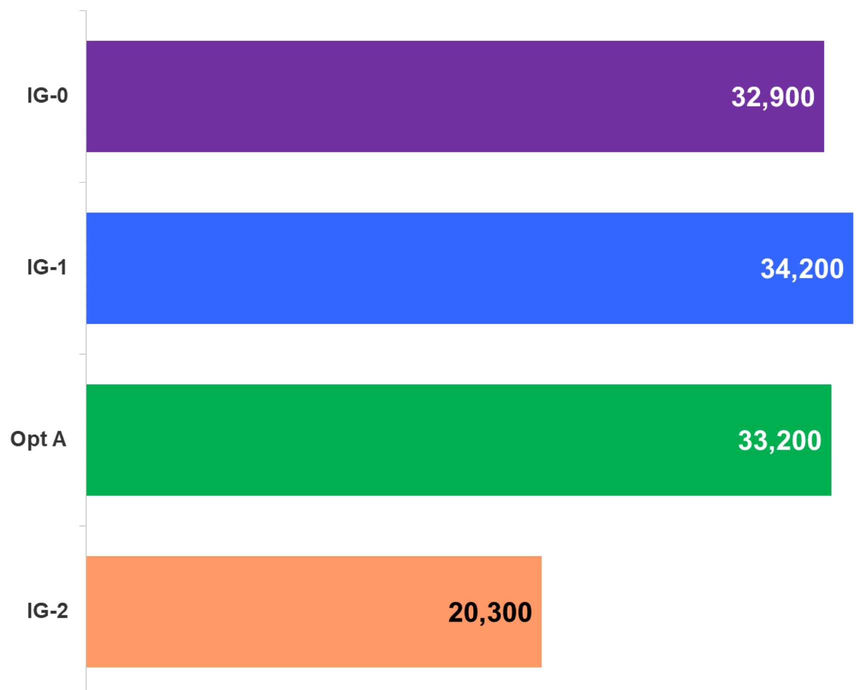


Figure 6-14: Comparison of Northbound FY 2040 Tunnel Volumes by Toll Scenario (6am to 9am)

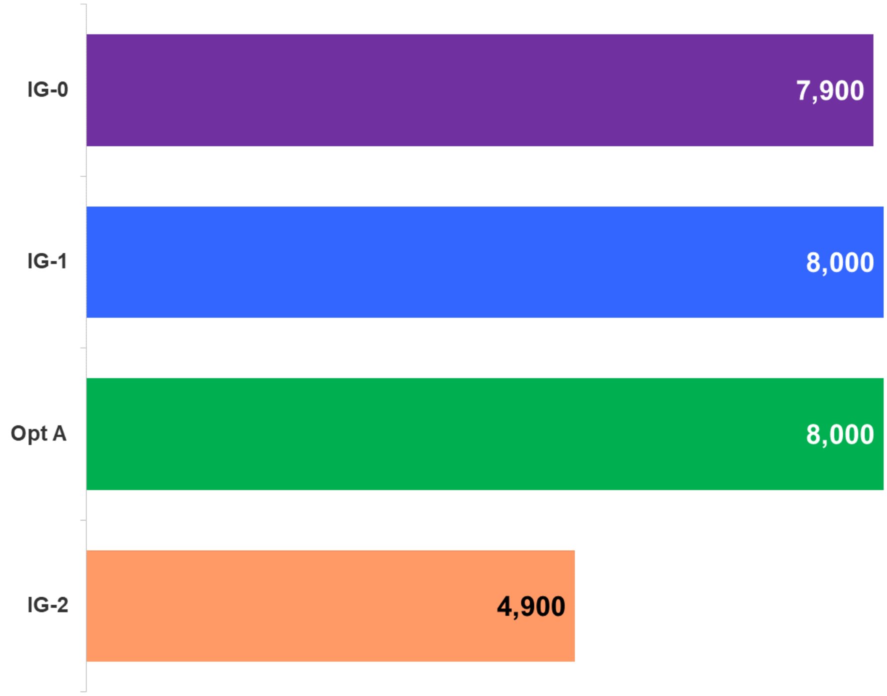


Figure 6-15: Comparison of Northbound FY 2040 Tunnel Volumes by Toll Scenario (9am to 3pm)

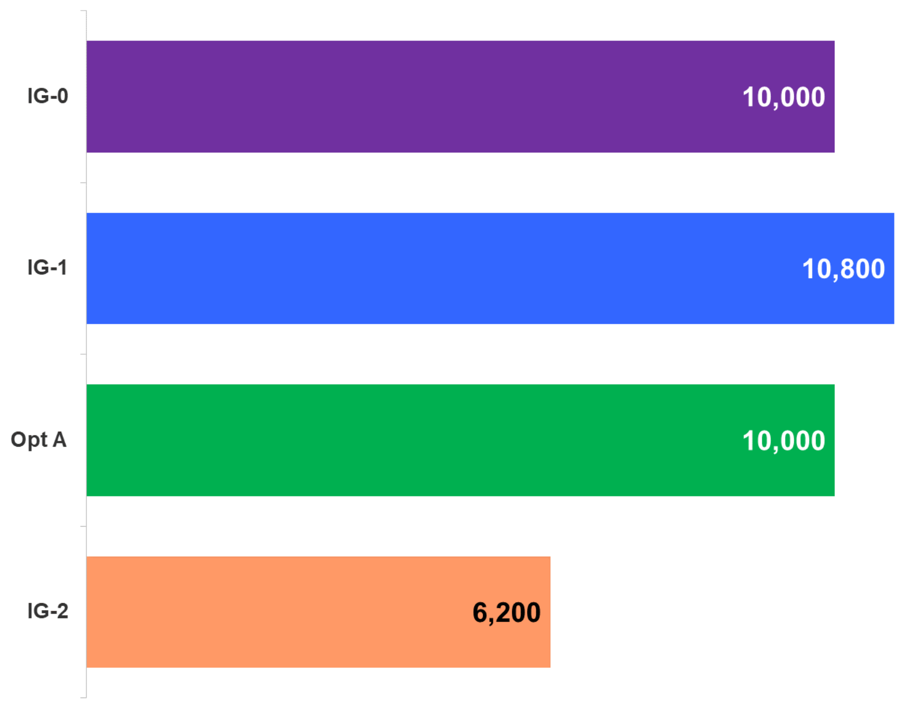


Figure 6-16: Comparison of Northbound FY 2040 Tunnel Volumes by Toll Scenario (3pm to 6pm)

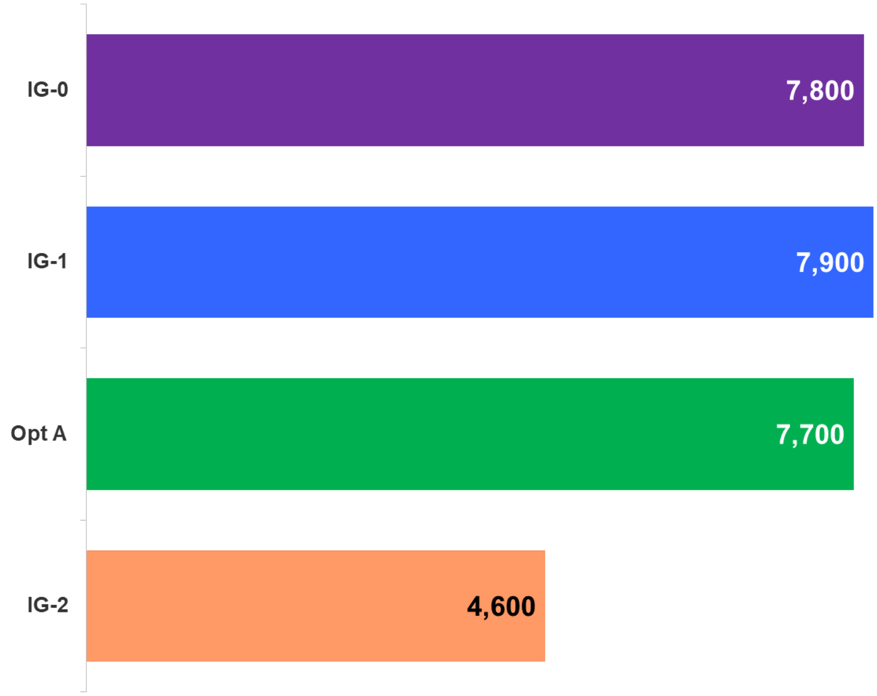


Figure 6-17: Comparison of Northbound FY 2040 Tunnel Volumes by Toll Scenario (6pm to 11pm)

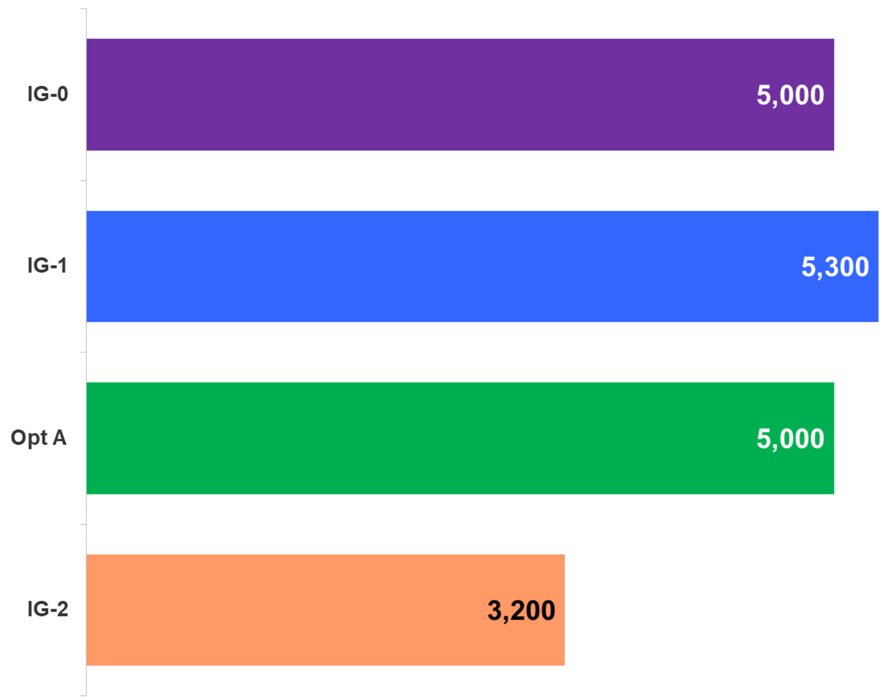


Figure 6-18: Comparison of Northbound FY 2040 Tunnel Volumes by Toll Scenario (11pm to 6am)

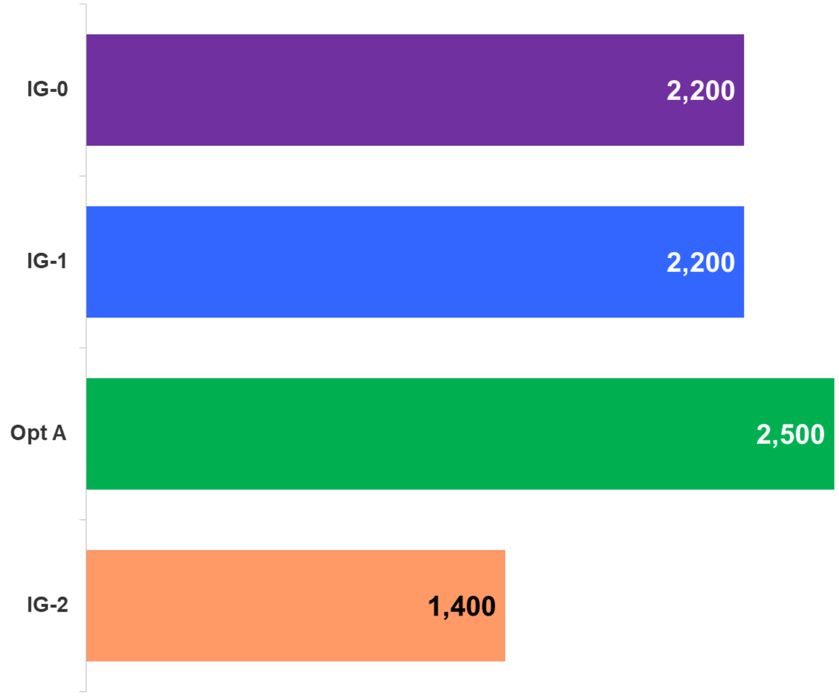


Figure 6-19: Comparison of Southbound FY 2040 Tunnel Volumes by Toll Scenario (Daily)

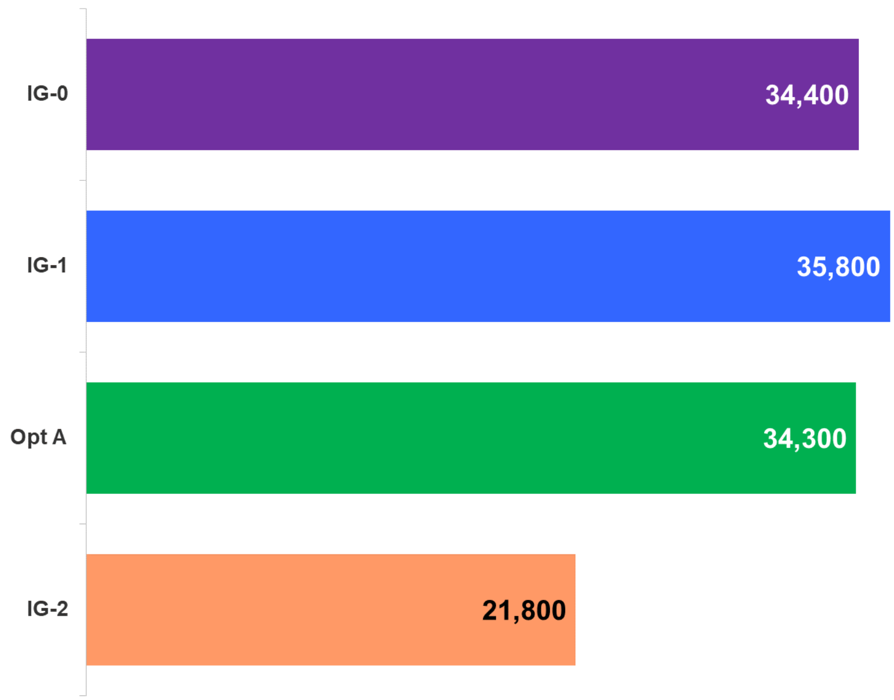


Figure 6-20: Comparison of Southbound FY 2040 Tunnel Volumes by Toll Scenario (6am to 9am)

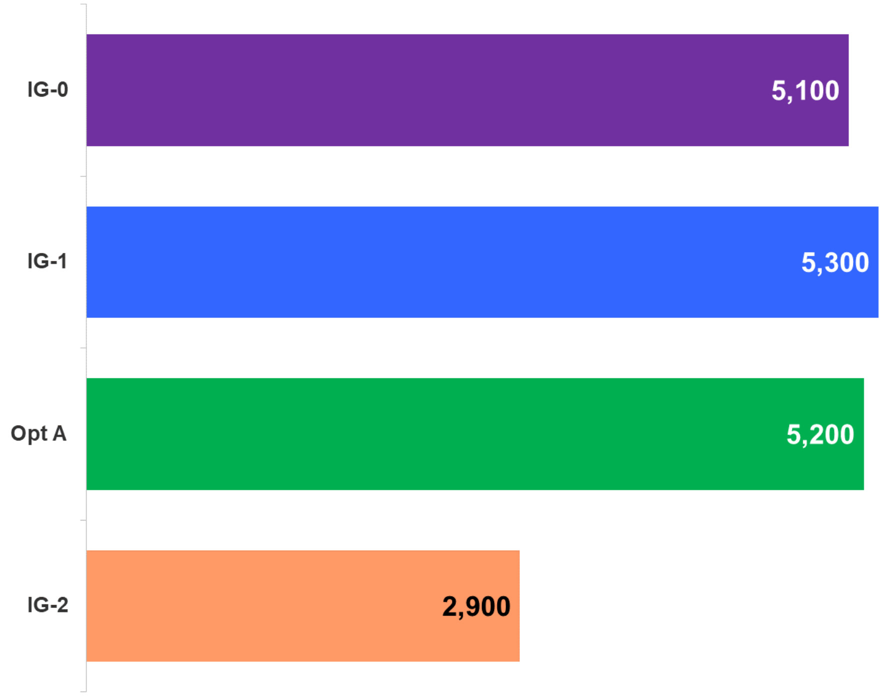


Figure 6-21: Comparison of Southbound FY 2040 Tunnel Volumes by Toll Scenario (9am to 3pm)

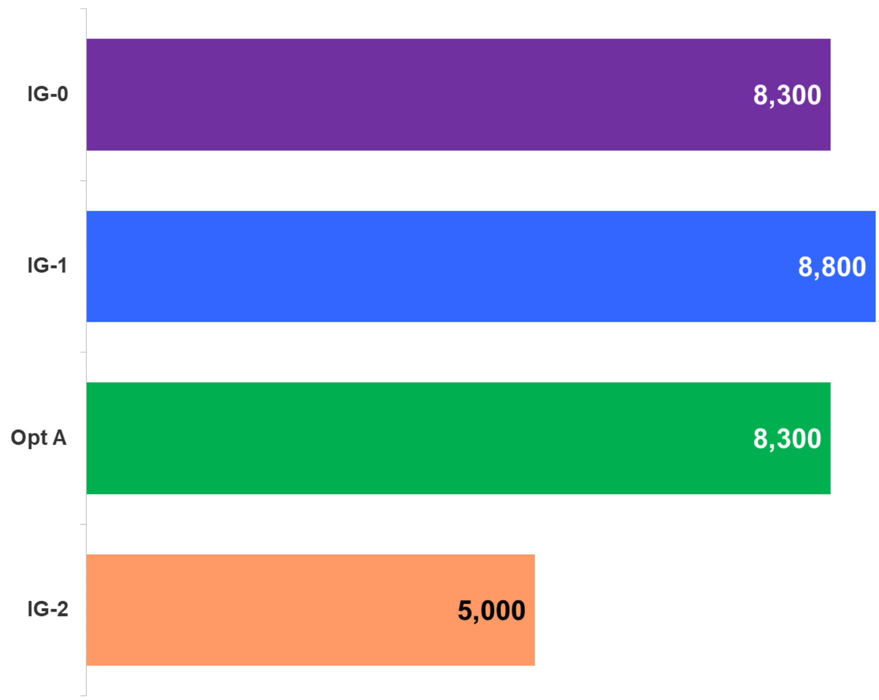


Figure 6-22: Comparison of Southbound FY 2040 Tunnel Volumes by Toll Scenario (3pm to 6pm)

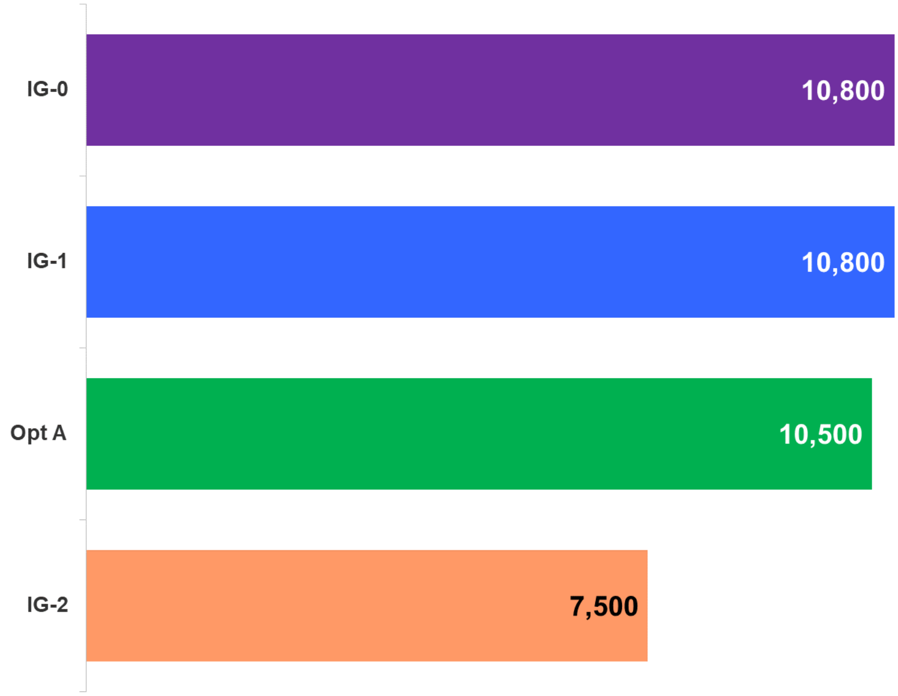


Figure 6-23: Comparison of Southbound FY 2040 Tunnel Volumes by Toll Scenario (6pm to 11pm)

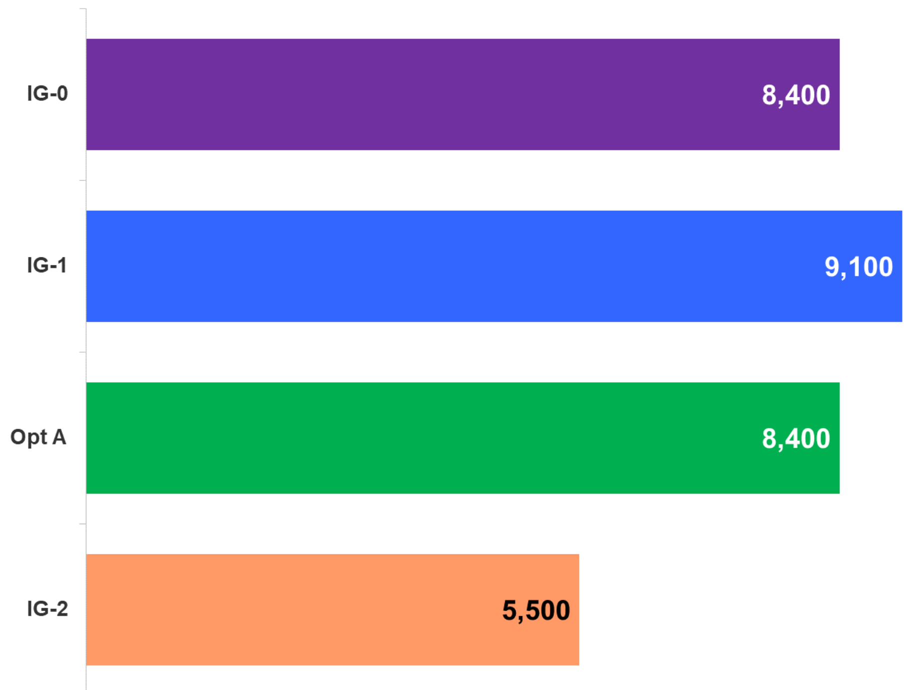
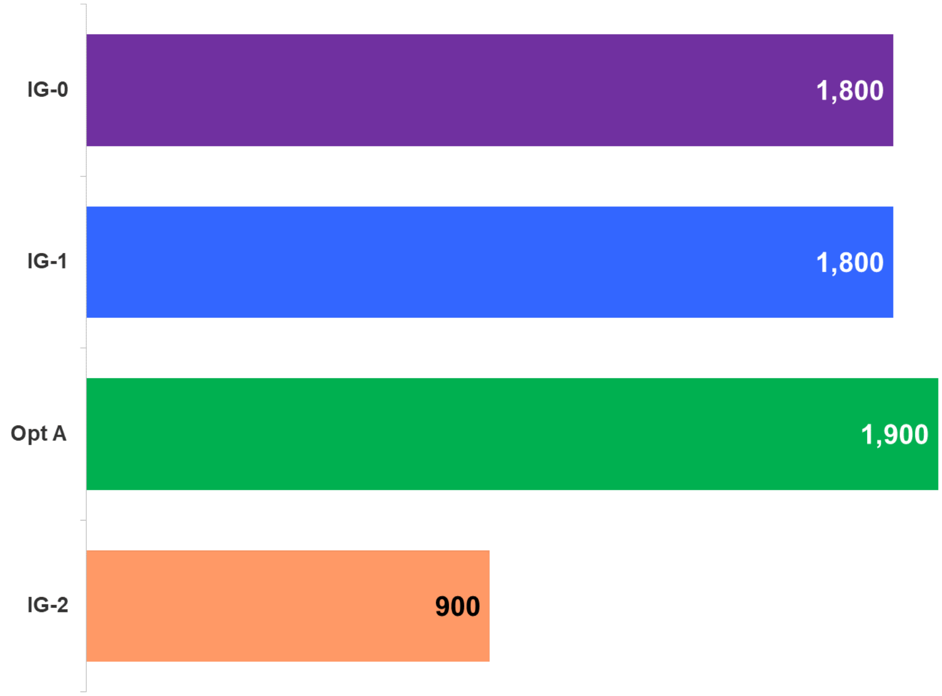


Figure 6-24: Comparison of Southbound FY 2040 Tunnel Volumes by Toll Scenario (11pm to 6am)



The following charts illustrate the weekday 24-hour volumes totaled across both directions and all vehicle classes for the four toll scenarios. **Figure 6-25** depicts the opening year conditions in FY 2020, whereas **Figure 6-26** shows conditions in FY 2040 after 20 years of a declining real toll rate and network travel growth.

Figure 6-25: FY 2020 Weekday Daily Traffic Profiles by Toll Scenario

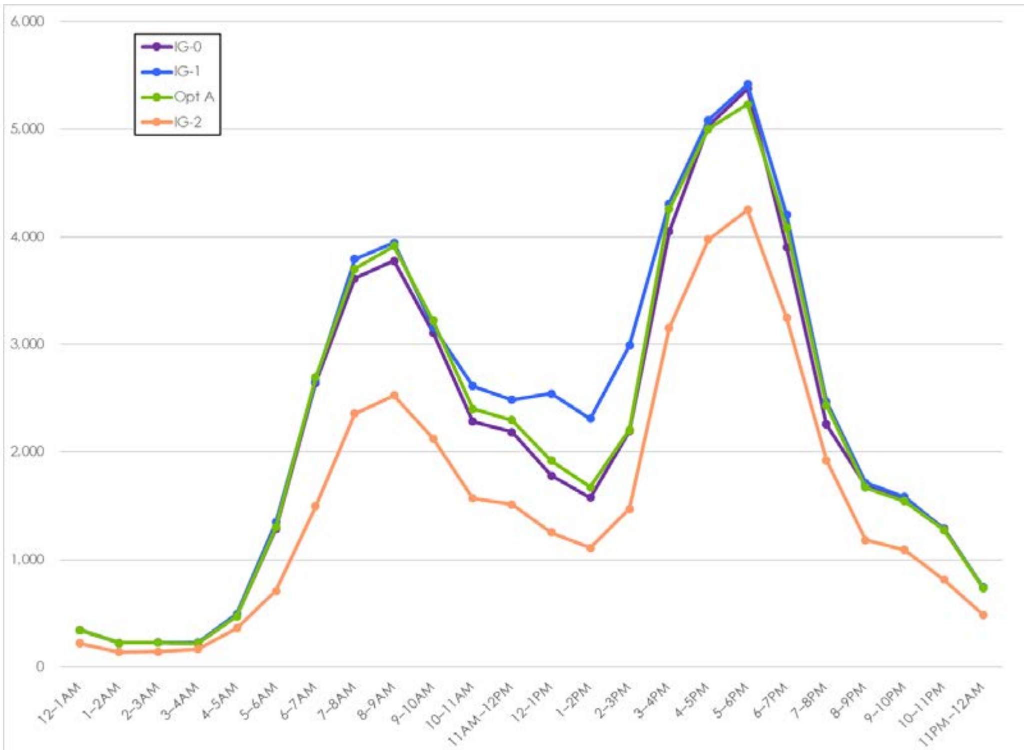
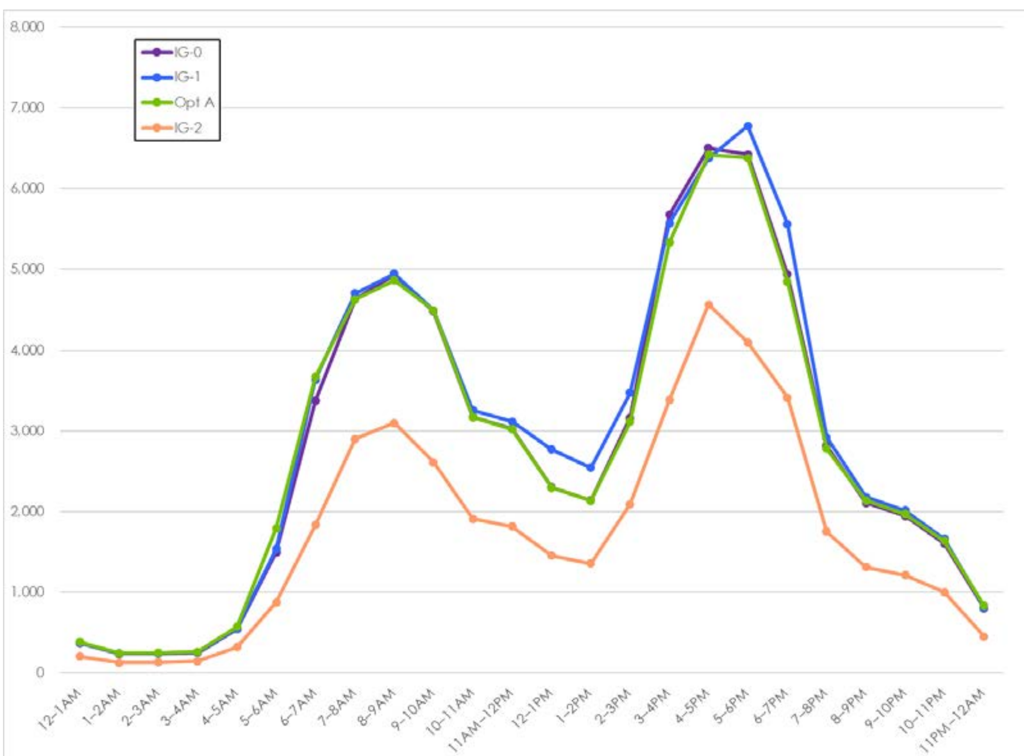


Figure 6-26: FY 2040 Weekday Daily Traffic Profiles by Toll Scenario



6.1.4.3 Tunnel Volumes by Vehicle Class

Table 6-4 and **Table 6-5** provide the average weekday toll volumes by vehicle class for each toll scenario for FY 2020 and FY 2040, respectively. Overall, trucks trips make up a small percentage of overall trips in the tunnel, ranging from 6 to 8 percent. It is important to note, that while the overall percentage of trucks looks higher in IG-2, the total number of trucks is much lower than other toll scenarios.

Table 6-4: FY 2020 Average Weekday Tunnel Volume by Vehicle Class

FY 2020	Total (24-hour) Daily Volume				Vehicle Classification by Toll Scenario			
Scenario	Total	Auto / Small Truck	Medium Truck	Large Truck	Total	Auto / Small Truck	Medium Truck	Large Truck
IG-0	51,900	49,100	1,000	1,800	100.0%	94.6%	1.9%	3.5%
IG-1	56,200	53,000	1,300	1,900	100.0%	94.3%	2.3%	3.4%
Opt A	53,000	50,000	1,100	1,900	100.0%	94.3%	2.1%	3.6%
IG-2	37,280	35,000	810	1,470	100.0%	93.9%	2.2%	3.9%

Table 6-5: FY 2040 Average Weekday Tunnel Volume by Vehicle Class

FY 2040	Total (24-hour) Daily Volume				Vehicle Classification by Toll Scenario			
Scenario	Total	Auto / Small Truck	Medium Truck	Large Truck	Total	Auto / Small Truck	Medium Truck	Large Truck
IG-0	67,300	63,100	2,000	2,200	100.0%	93.8%	3.0%	3.3%
IG-1	70,000	65,600	1,800	2,600	100.0%	93.7%	2.6%	3.7%
Opt A	67,400	62,900	1,900	2,600	100.0%	93.3%	2.8%	3.9%
IG-2	42,070	38,700	1,350	2,020	100.0%	92.0%	3.2%	4.8%

6.1.4.4 DTA Model System-wide Results

For the FY 2020 and FY 2040 forecast years, the SR 99 toll tunnel traffic was projected under tolled scenarios for the AM (6am to 9am) and MD/PM (1pm to 6pm) periods. The DTA model system-wide results are summarized in **Table 6-6** and **Table 6-7** for FY 2020 and FY 2040, respectively. The tables show a logical relationship between toll scenarios. In addition, higher level of traffic congestion should be expected when transitioning from FY 2020 to FY 2040 due to incremental increases in travel demand within the study area which encompasses the Seattle CBD and vicinity.

Table 6-6: FY 2020 DTA Model VMT, VHT, VHD, Speed Summary

	AM			MD/PM		
	IG-0	IG-1	Opt A	IG-0	IG-1	Opt A
Total VMT (miles)	1,275,800	1,270,984	1,271,077	1,999,885	1,998,841	2,003,137
Total VHT (hours)	45,512	45,026	44,527	75,609	74,052	75,023
Total VHD (hours)	18,157	17,781	17,278	31,713	30,208	31,073
Average Speed	28.0	28.2	28.5	26.5	27.0	26.7
Average Trip Length (miles)	3.7	3.7	3.7	3.4	3.4	3.4

Table 6-7: FY 2040 DTA Model VMT, VHT, Speed Summary

	AM			MD/PM		
	IG-0	IG-1	Opt A	IG-0	IG-1	Opt A
Total VMT (miles)	1,363,663	1,359,739	1,362,528	2,137,190	2,135,048	2,137,009
Total VHT (hours)	56,037	55,242	54,944	95,143	89,609	92,603
Total VHD (hours)	26,644	25,939	25,594	47,950	42,528	45,446
Average Speed	24.3	24.6	24.8	22.5	23.8	23.1
Average Trip Length (miles)	3.6	3.6	3.6	3.4	3.4	3.4

6.1.5 Annual Traffic and Gross Toll Revenue Forecasts

6.1.5.1 Annualization

The average weekday daily traffic (AWDT) modeled for each scenario, direction, vehicle class, and hour of the day are combined into daily period volumes per the periods shown in the rightmost column of **Table 6-1**, for both FY 2020 and FY 2040. Converting AWDT to annual traffic demand requires interpolation of traffic growth rates in the years between FY 2020 and FY 2040, as well as extrapolation beyond FY 2040, estimating weekend demand and growth, splitting transactions into payment types, and applying the toll rates to the respective annual traffic. The vehicle class, time of day, and direction of travel are maintained and calculated separately throughout the annualization calculations.

Traffic for FY 2020 and FY 2040 serve as points from which to interpolate and extrapolate traffic growth rates in intermittent years. Beyond FY 2040, growth in traffic volumes are assumed to slow.

After the appropriate growth rates are applied, the AWDT in each year is annualized by an assumed factor of 251 weekdays per year, which excludes weekends and major weekday holidays. Because weekend traffic is not provided, the toll-free weekday traffic is scaled down based on the existing observed toll-free weekend traffic as a share of toll free weekday traffic. Weekend toll traffic is then derived from the level of weekday versus weekend demand for the toll-free scenario and the midday ($1.00 toll) diversion rate. Effectively, the share of weekend toll-free traffic retained with the toll is less than or equal to the corresponding weekday midday retention rate, varying lower outside of peak weekend midday hours. The average daily weekend traffic is converted to an annual amount under the assumption that there are 114 weekend and weekday holiday days per year.

Table 6-8 below shows the effective weekday-to-annual expansion factors for traffic and revenue by toll scenario that result from the above weekend-day forecast assumptions. As toll rates increase with each scenario, average weekday traffic decreases while weekend traffic remains the same as toll rates on the weekend are set at $1.00 for each scenario. Therefore, the differential between the average weekday and weekend traffic lessens and the annual expansion factor rate increases. Conversely, as toll rates increase, the revenue generated on an average weekday increases in comparison to the weekend revenue, which leads to lower annual expansion factors as toll rates increase.

Table 6-8: Annualization Factors

Scenario	Traffic	Revenue
IG-0: Financial Plan	305	285
IG-1: Low Diversion	305	295
Opt A: Rate Setting	305	290
IG-2: Revenue Maximization	330	270

After determining total annual transactions by year, the transactions are split into payment types based on assumed share of Good To Go! versus Pay By Mail (non-account) transactions. Initially, the Good To Go! market share is 75%, but increases gradually over a twenty-year period to an 85% ceiling in FY 2040, after which it remains constant.

6.1.5.2 Ramp-Up

Other traffic adjustments include ramp-up in the early years and a factor to adjust for the tolling start date. Ramp-up factors are applied to annual traffic and revenue to reduce the forecasted traffic and revenue due to lag in adoption and use of the toll facility as customers evaluate their options and become accustomed to the benefits and operations of the toll facility. Given the number of toll-free alternatives in the downtown Seattle area, it is assumed the ramp-up period could last several years. **Table 6-9** and **Table 6-10** summarize the ramp-up assumptions for the first few years of operation.

Table 6-9: Ramp-Up Assumptions – IG-0, IG-1, and IG-2

Fiscal Year	Ramp-Up Assumption	Forecast Reduction
2019	75%	25%
2020	80%	20%
2021	97%	3%

Table 6-10: Ramp-Up Assumptions – Option A

Fiscal Year	Ramp-Up Assumption	Forecast Reduction
2020	78%	22%
2021	91%	9%
2022	99%	1%

6.1.5.3 Tunnel Closures

The forecast assumes that the tunnel will need to be closed for maintenance purposes 88 times each year. While the majority of these closures are lane closures that would be completed overnight and on weekends when demand is low, there are 12 proposed full closures that would occur on weekends. The forecast for both traffic and revenue was reduced to account for these 12 proposed closures on weekends.

6.1.5.4 Traffic and Gross Toll Revenue Calculations

Figure 6-27, **Figure 6-28**, and **Figure 6-29** illustrate the toll transaction forecasts by payment method (Good To Go!, Pay By Mail, and total) for the four toll scenarios analyzed as part of the investment grade forecast. It should be noted that Pay By Mail transactions decrease between FY 2020 and FY 2040 as it is projected a shift in payment type from 25 percent to 15 percent of overall transactions will be Pay By Mail. This shift in payment type exceeds the overall transaction growth rate, leading to decreasing Pay By Mail transactions. After FY 2040, it is assumed 15 percent of all transactions will remain Pay By mail. Since overall transactions grow, the number of Pay By Mail transactions grows after FY 2040.

Figure 6-27: GTG Transactions by Toll Scenario

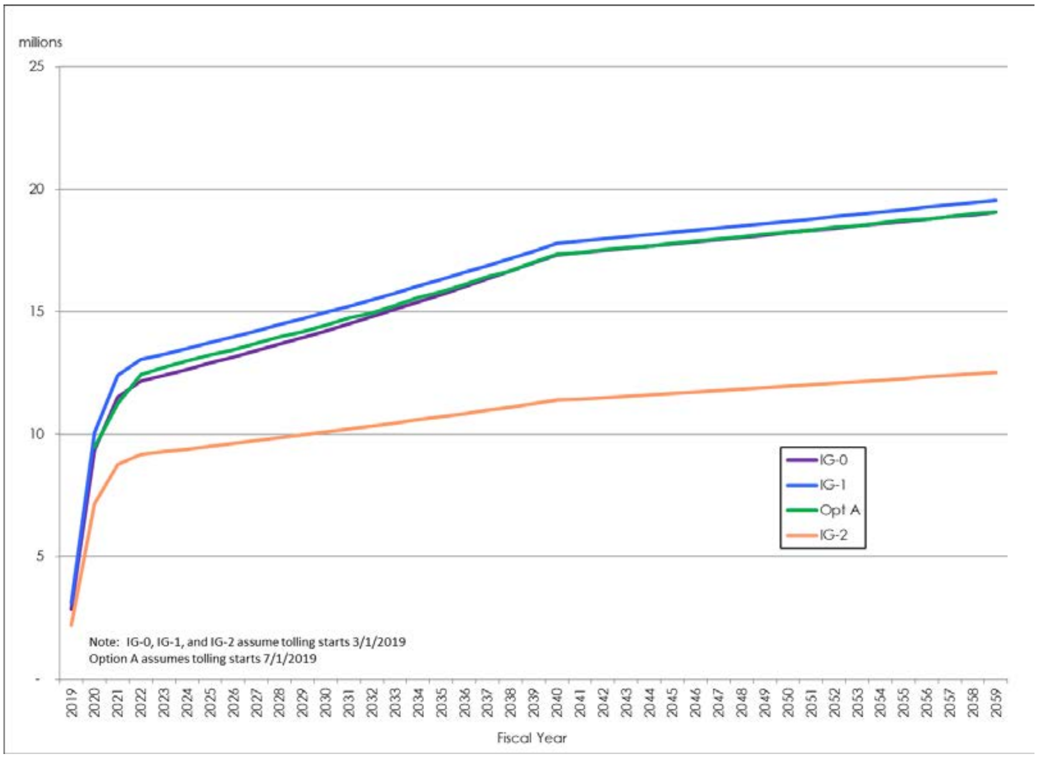


Figure 6-28: PBM Transactions by Toll Scenario

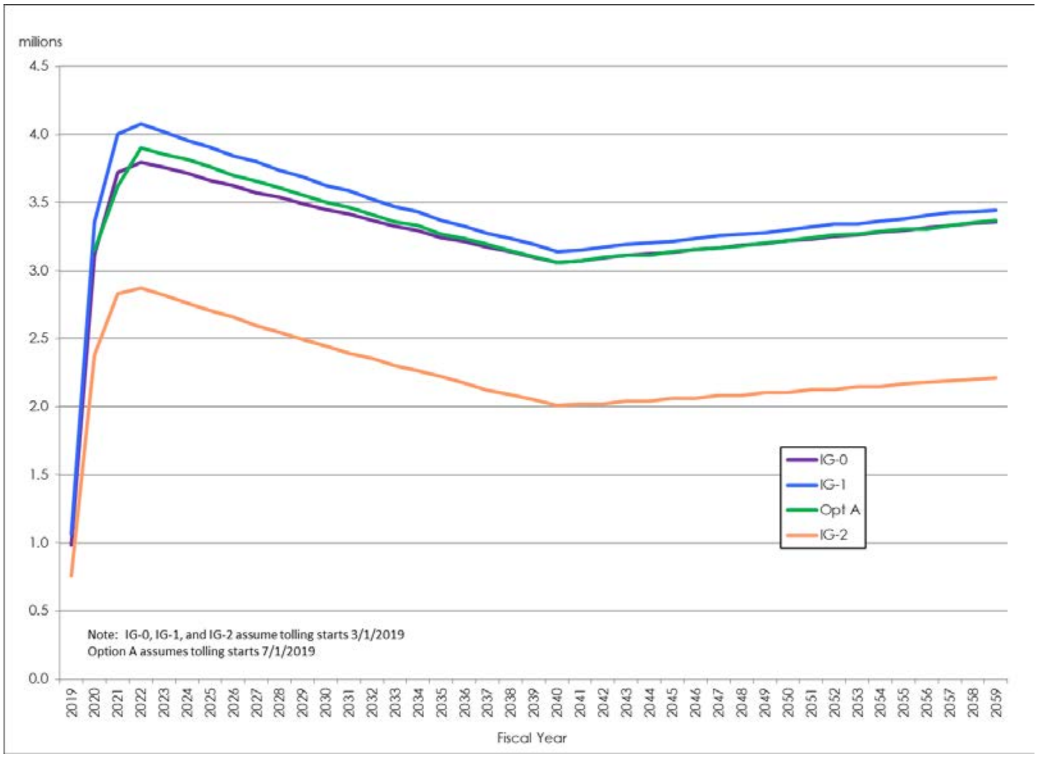
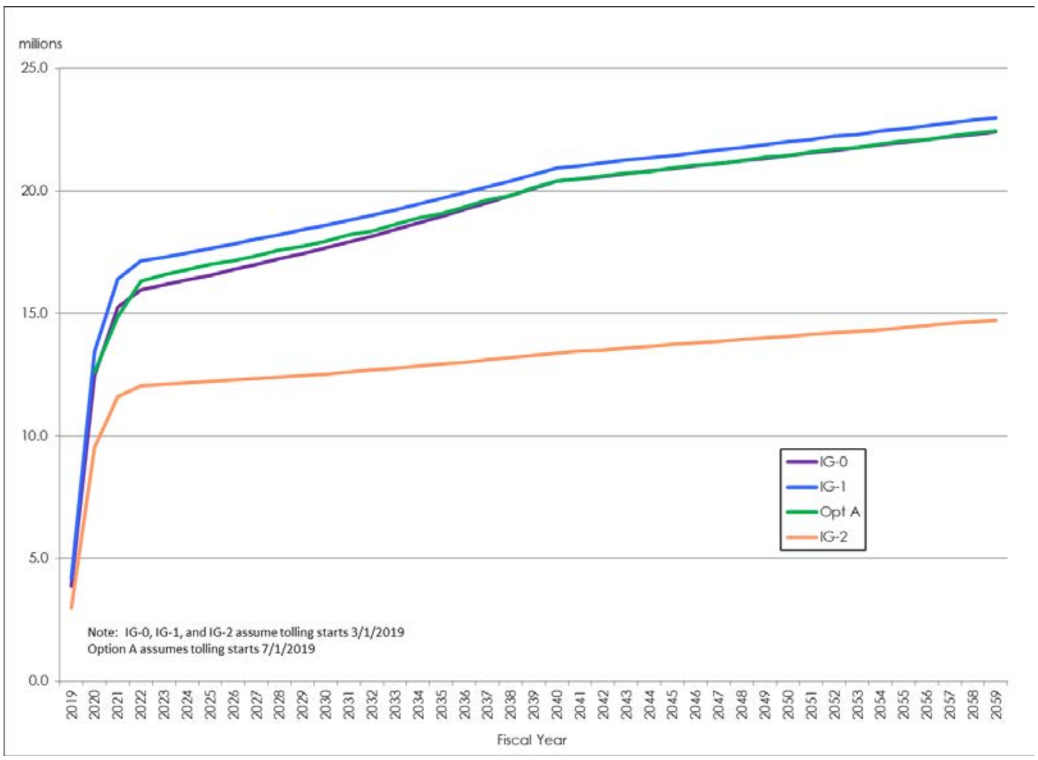


Figure 6-29: Total Transactions by Toll Scenario



The toll rates specified in **Table 6-3** were multiplied by the corresponding weekday annual forecast period volumes to yield the annual weekday revenue. Toll rates are applied by time period, direction, and vehicle class with truck toll multipliers of 1.06x the auto toll for medium trucks and 2.09x for large trucks. Gross toll revenue is calculated by multiplying traffic by vehicle class, payment method, and time period by the appropriate toll.

Figure 6-30, **Figure 6-31**, and **Figure 6-32** illustrate the gross toll revenue potential forecasts by payment method (Good-To-Go!, Pay By Mail, and total) for the four toll scenarios that were forecast as part of the investment grade study. It is important to remember that IG-2 assumes toll will escalate at 2.5 percent per year for the life of the forecast and Opt A assumes toll escalation of 3.0 percent every three years beginning in FY 2023 whereas IG-0 and IG-1 assume no toll escalation. Toll escalation plays a significant role in the difference in revenue growth rates between IG-0, IG-1, and IG-2. Also, as discussed above, a shift in payment type from Pay By Mail leads to decreasing (or slowly increasing for IG-2) revenue between FY 2020 and FY 2040. After FY 2040, since overall transactions grow, Pay By Mail revenue grows.

Figure 6-30: GTG Gross Revenue by Toll Scenario

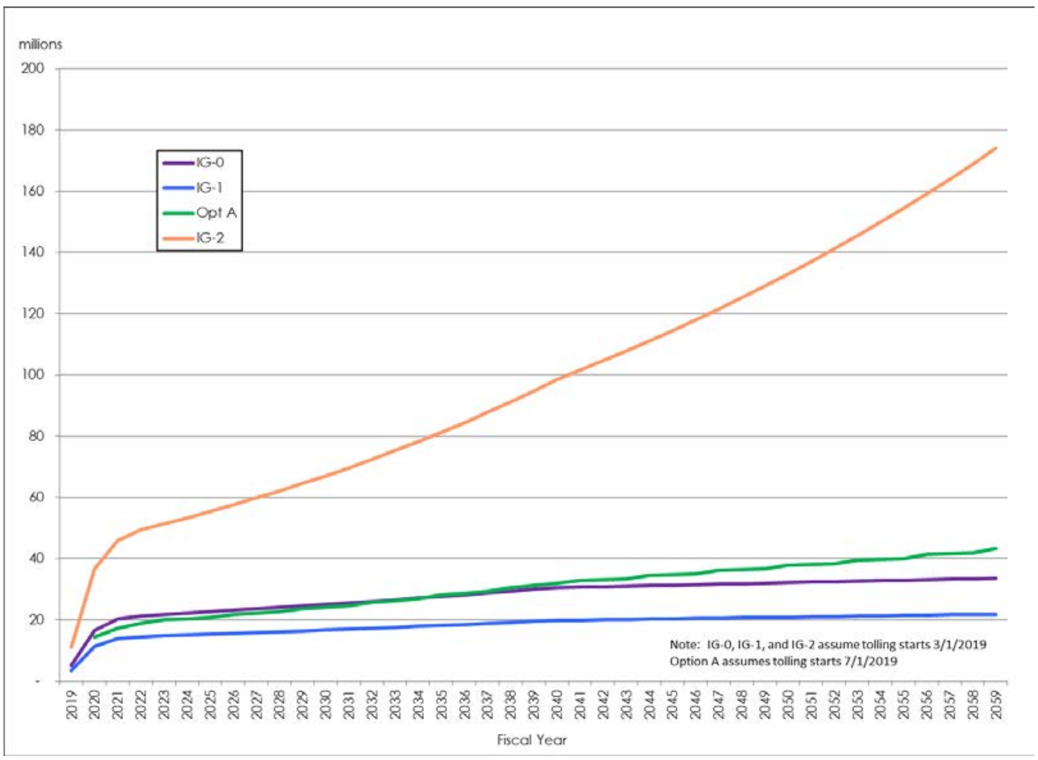


Figure 6-31: PBM Gross Revenue by Toll Scenario

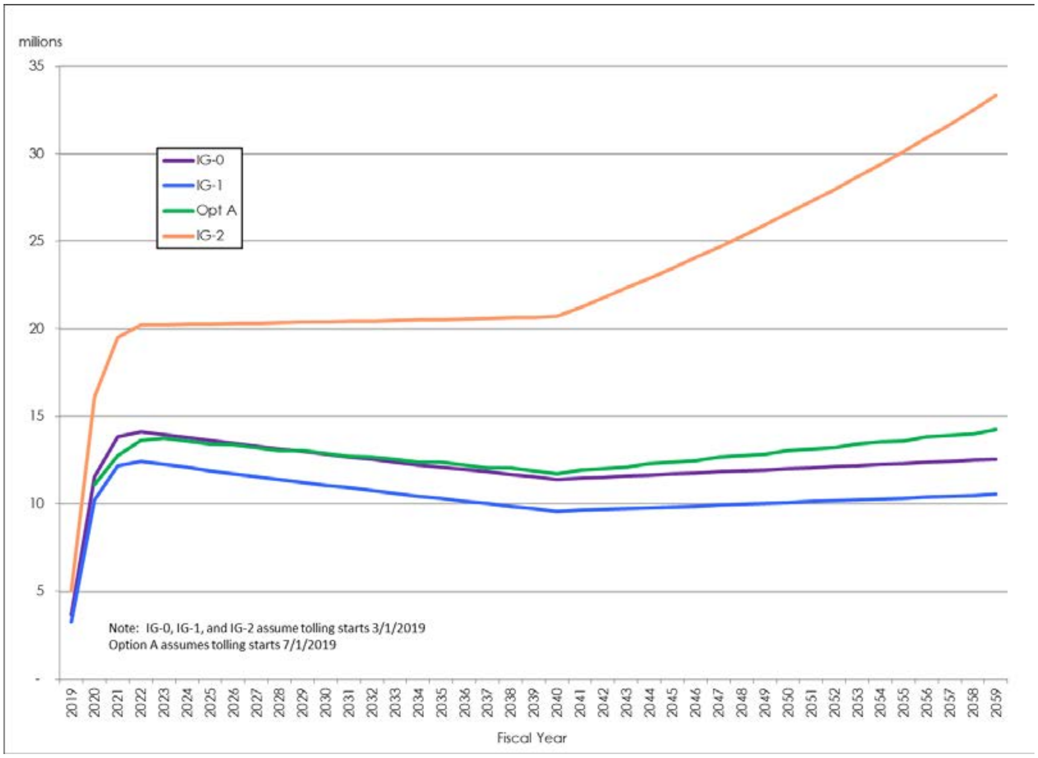
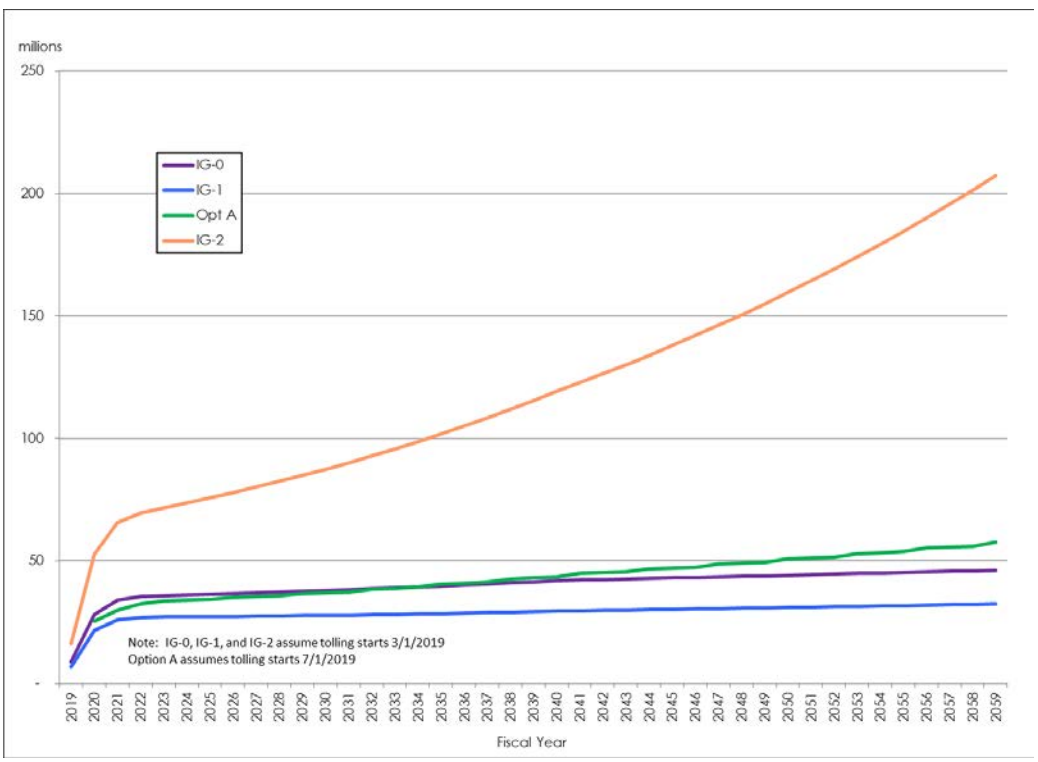


Figure 6-32: Total Gross Revenue by Toll Scenario



7.0 NET REVENUE FORECAST

This section describes the process by which net toll revenue projections — the cashflows available to support capital investment including repair and replacement (R&R) and financing — were developed for each of the four investment-grade (IG) toll scenarios listed in section 6.0.

7.1 GROSS TO NET TOLL REVENUE PROCESS

Starting with the annual toll transactions and gross toll revenue potential forecasts developed for the four toll scenarios, adjustments are made for various payment fees and discounts, revenue leakage, and routine operations and maintenance (O&M) costs associated with both toll collection and tunnel/roadway maintenance functions. The primary components of the gross-to-net revenue flow of funds or "waterfall" are shown in **Figure 7-1** and include the following:

Revenue and Fee Adjustments

- Toll payment fees and discounts
  - o Pay By Plate fee revenue
  - o Self-initiated payment credit (short-term account discount)
- Pay By Mail rebilling fees
- Uncollectible revenue
  - o Revenue not recognized
  - o Unpaid toll revenue
- Recaptured and recovered tolls
- Civil Penalty revenues (Option A only)

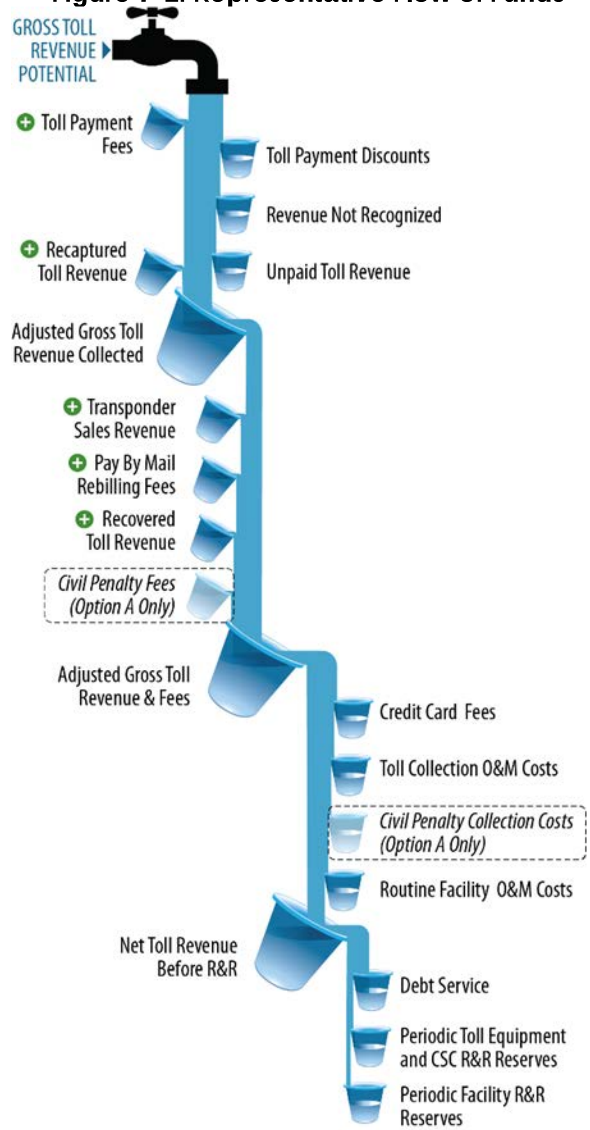
Operations and Maintenance (O&M) Costs

- Credit card fees
- Routine toll collection O&M
  - o Transponder purchase and inventory costs
  - o State operations costs
  - o Customer service center (CSC) vendor costs
  - o Roadway Toll Systems (RTS) vendor costs
- Civil penalty collection costs (Option A only)
- Routine facility O&M costs

Repair and Replacement (R&R) Costs

- Toll collection R&R costs
- Facility repair and replacement (R&R) costs

Figure 7-1: Representative Flow of Funds



7.2 ADJUSTED GROSS TOLL REVENUE COLLECTED

Annual toll transactions and gross toll revenue potential forecasts for the four toll scenarios for FY 2019 through FY 2059, as shown in **Figure 6-27** through **Figure 6-32**, represent the starting point for the gross-to-net revenue calculations. Transactions by primary payment method (*Good To Go!* Transponder Account, *Good To Go!* Pay By Plate Account, and Pay By Mail / No Account) serve as the basis to calculate potential revenue leakage from revenue not recognized due to a faulty license plate image or invalid owner's name and address as well as non-payment of toll bills. Gross toll revenue potential for non-account customers is already assumed to include the $2.00 Pay By Mail toll differential, consistent with other operational toll facilities. However, adjustments are made for the $0.50 payment discount associated with non-account customers who self-initiate payment prior to a toll bill being mailed, and the $0.25 fee for *Good To Go!* account customers who opt to be identified by license plate rather than transponder pass.

Figure 7-2: SR 99 Toll Transaction Activity Workflow

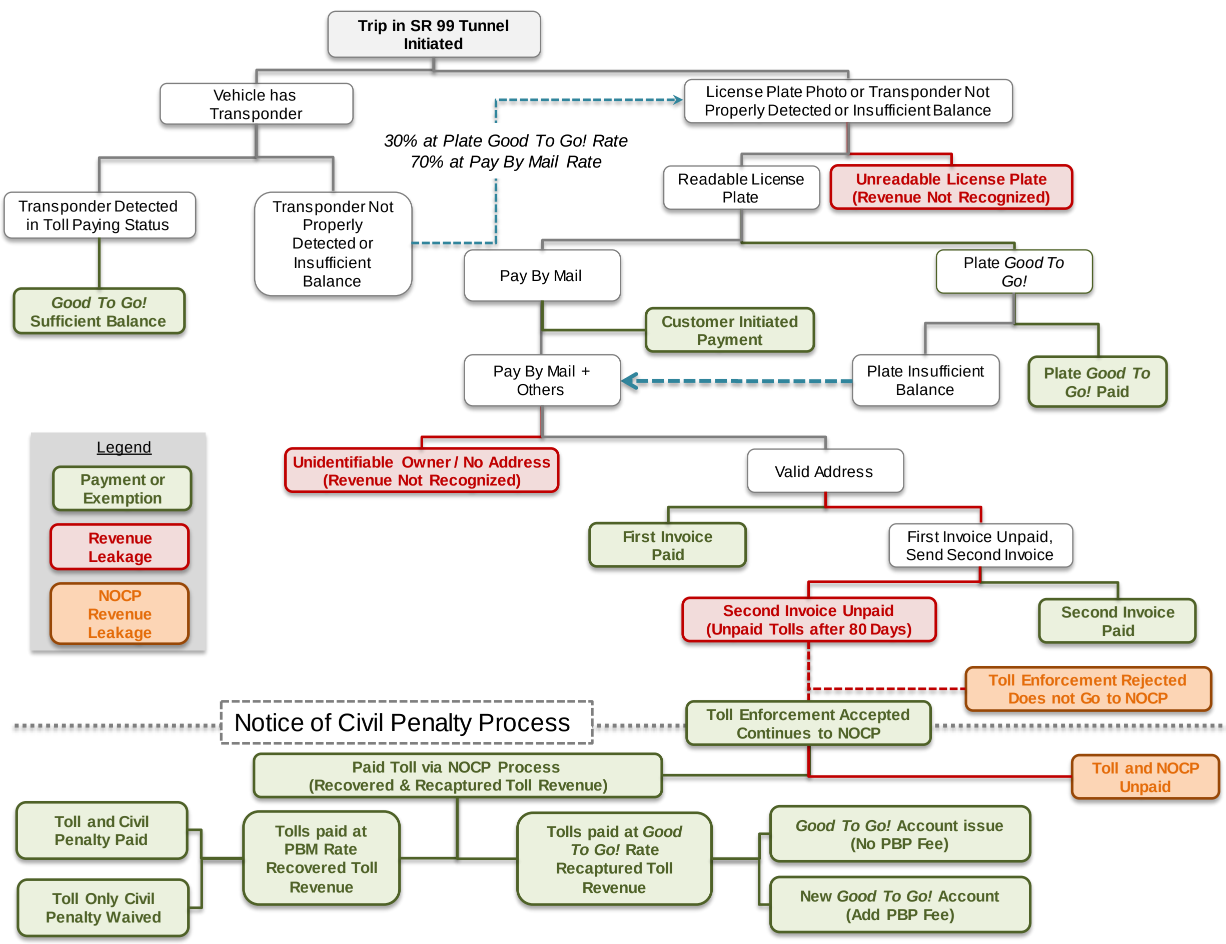


Figure 7-2 above shows the assumed transaction activity workflow for trips taken in the SR 99 tunnel. Note this flowchart figure has been simplified to include the most likely transaction flows and does not include every possible transaction flow outcome modeled, leaving out certain small volume, low probability outcomes. Flowchart boxes with green shading represents

transactions that are assumed to be resolved and successfully processed, white or clear shading represents in-process transactions, red shading represents revenue leakage transactions prior to civil penalties, and orange shading represents revenue leakage during the civil penalty process.

7.2.1 Toll Payment Discounts and Fees

Account-based customers who choose to pre-register a vehicle's license plate (Pay By Plate) in lieu of installing a transponder in that vehicle are charged a $0.25 fee per transaction; these travelers are assumed to represent about 18-19 percent of *Good To Go!* customers, or about 15 percent of total transactions. The $0.25 fee is assumed to be constant with no annual escalation.

Customers traveling without a pre-paid account who self-initiate payment before a toll bill is sent to them are assumed to receive a credit of $0.50 per transaction. These travelers are assumed to be a very small share of non-account customers with readable license plates (0.2 percent) and the $0.50 credit is assumed to be constant with no annual escalation. It should be noted that although the net revenue projections prepared for all four toll scenarios include this minor customer discount, the WSTC adopted toll rates (Option A) have now excluded the discount previously assumed for this payment option, as the discount has been phased out on all of the WSDOT toll facilities.

7.2.2 Revenue Not Recognized

Revenue not recognized occurs when a license plate is unreadable, or when the vehicle owner and address from a readable license plate cannot be identified.

The revenue not recognized associated with unreadable license plates is assumed to be 5.5 percent in FY 2019 of total image-based transactions and *Good To Go!* transponder transactions in which the transponder was either misread or the account had an insufficient balance. The 5.5 percent rate in FY 2019 is a conservative assumption compared to typical industry experience between 3.5 and 4.5 percent. The higher rate of leakage is attributed to SR 99 being a new facility with new toll equipment along with WSDOT's transition to a new system-wide customer service center (CSC) systems and operations vendor in FY 2019. The initial higher rate of 5.5 percent is expected to be reduced to 5.0 percent in FY 2020 and 4.5 percent in FY 2021 as operations transition into a steady state, where it is assumed to remain for the remainder of the forecast horizon.

Once the license plate image has been successfully validated, the percentage share of transactions associated with an invalid registration or inability to obtain a correct owner addresses is assumed to be 10.5 percent. The 10.5 percent assumption is based on actual data in Washington State and the experience with the current CSC vendor. The rate is significantly higher than industry experience ranging between 3-5 percent. Similar to unreadable images it is expected that as the new system-wide vendor ramps up operations and transitions to steady-state, leakage rates will decrease to 7.5 percent in FY 2020, and to 4.5 percent in FY 2021 where it is assumed to remain for the remainder of the forecast horizon.

7.2.3 Unpaid Toll Revenue

Unpaid Toll Revenue is a measure of the Pay By Mail revenues from toll transactions with readable license plates, identified owners, and thus toll bills mailed that are not collected within two billing cycles or 80 days. This measure excludes the benefits of any recovery efforts after 80 days.

Based on system-wide historical performance of first toll invoices mailed on WSDOT toll facilities, less than 37 percent are assumed to go unpaid in the first month, with a second toll invoice then mailed to these customers. Of the second invoices sent, less than 60 percent are assumed to go unpaid after 80 days, upon which they transferred over to the civil penalty process. As most of the unpaid toll bill challenges are associated with vehicle registration records that are not directly related to CSC operations activity, we do not assume any improvement in payment rates with the transition to a new CSC back office operations vendor.

For purposes of the SR 99 net revenue projections, a slightly more conservative unpaid toll leakage rate was assumed with 40 percent of first toll invoices mailed assumed to go unpaid and 63 percent of second invoices mailed also going unpaid and transferred to the civil penalty process after 80 days. These assumptions translate into an overall toll bill payment rate of 74.8 percent from first and second invoices, prior to adjustments for toll revenue recovery efforts in the civil penalty process.

7.2.4 Recaptured Toll Revenue at *Good To Go!* Rates

Customers who fail to pay their tolls during the regular two invoice / 80-day billing cycle will receive a notice of civil penalty (NOCP) equal to $40 for each overdue toll owed. Specifically, 87 percent of invoiced transactions unpaid after 80 days are assumed to have sufficient information to be certified for a notice of civil penalty by a WSDOT toll enforcement officer, with the remaining 13 percent dismissed, consistent with other WSDOT toll facilities.

Customers receiving a NOCP will have the opportunity to remit payment for tolls and fees, or request a hearing to avoid having their motor vehicle registration withheld from renewal and/or have the amount due sent to collections. The portion of NOCP transactions from which the toll is assumed to be recovered through the civil penalty adjudication process and subsequent collection efforts is assumed to be 40 percent based on existing experience.

A new policy implemented at the beginning of FY 2016 allows for more leniency in the handling of customers who are repeatedly failing to pay their toll bills. Referred to as the Customer Program for Resolution (CPR), this policy allows customers to open a new *Good To Go!* account by phone (or in person at the CSC) and resolve their unpaid tolls at the appropriate *Good To Go!* rate without payment of one or more civil penalties. Similarly, customers with existing *Good To Go!* accounts with an insufficient account balance for reason of an expired or changed credit card who end up receiving a NOCP are offered the opportunity to rectify their account and make payment, again without civil penalty.

There are two primary categories for toll revenue recovery in the civil penalty process that are defined by the rate by which the toll is recovered (*Good To Go!* or Pay By Mail) and where the toll revenue is captured in financial reporting, so as to align the forecast with the accounting of actual values when the facility is operational.

- **Recaptured Toll Revenue at *Good To Go!* Rates** is primarily the result of revenue captured through the CPR option (typically without civil penalty) and listed under adjusted gross toll revenue collected, and it aligns with "toll revenue" as reported in WSDOT quarterly financial statements.
- **Toll Revenue Recovered at Pay By Mail Rates** is listed under Adjusted Gross Toll Revenue and Fees (Section 7.3), may be associated with civil penalties, and is assumed to be held in a separate civil penalty account that requires legislative authorization to transfer to the toll account, as discussed in a later section.

Recaptured toll revenue at *Good To Go!* rates is estimated to be 57 percent of transactions for which customers received NOCPs in the mail and took some kind of action, the remaining 43 percent are processed at the Pay By Mail rate and if paid, included in the recovered toll revenue category. Of the resolved *Good To Go!* transactions, half are assumed to be resolved at the base *Good To Go!* transponder rate and half are assumed to be *Good To Go!* Pay By Plate transactions with an additional $0.25 fee. Toll revenues recaptured at *Good To Go!* rates, both transponder and Pay By Plate, from the civil penalty process are assumed to be collected partially in the fiscal year of travel and partially in the following fiscal year to account for an average six month lag from the date of travel for toll bill processing, first and second invoice notification, NOCP notification, and subsequent resolution of payment.

7.3 ADJUSTED GROSS TOLL REVENUE AND FEES

Adjusted Gross Toll Revenue Collected is further adjusted to account for transponder sales revenue, late payment fees associated with Pay By Mail transactions paid after mailing a second invoice or through the civil penalty process, and toll revenue recovered at Pay By Mail rates through the civil penalty process.

7.3.1 Transponder Sales Revenue

WSDOT purchases, retains, and sells *Good To Go!* transponders, including directly to customers via online/mail orders, at CSC walk-in locations, and through third-party retailers. Transponder sales revenues are projected to directly offset and match the transponder purchase, inventory, and distribution costs in every forecast year. Transponder costs are described in section 7.4.5.

7.3.2 Pay By Mail Rebilling Fees

A late payment fee of $5.00 per invoice is assessed to non-account customers who fail to pay their first mailed toll bill invoice within 30 days. The late fee is attached to the second invoice for one or more toll transactions and is assumed to remain constant over the forecast period with no annual escalation. Rebilling fee revenues are primarily driven by the forecasted volume of Pay By Mail transactions, assuming 2.76 transactions per invoice, with secondary effects coming from potential changes in the rate of payment of first and second toll invoices.

The forecast assumes that 37 percent of customers who receive a second invoice will pay the toll and associated late payment fee. Of the invoices that go unpaid after 80 days, 87 percent are assumed to be certified for a notice of civil penalty by a WSDOT toll enforcement officer, with the remaining 13 percent dismissed, primarily due to incorrect customer or vehicle identification. The portion of NOCP transactions from which the toll is assumed to be recovered through the CPR or normal civil penalty adjudication process and subsequent collection efforts is assumed to be 40 percent and for the 43 percent of such transactions for which tolls are recovered at the Pay By Mail rate, the $5 rebilling fee is also assumed to be recovered. For the remaining 57 percent of transactions for which the toll revenue is recaptured at the Good To Go! rate via the CPR program, no rebilling fees are assumed to be collected.

7.3.3 Toll Revenue Recovered at Pay By Mail Rates

Outlined in 7.2.4 there are two primary categories for toll revenue collected through the Civil Penalty process. In both cases, most customers who fail to pay their tolls during the regular two invoice / 80-day billing cycle will receive a notice of civil penalty equal to $40 for each overdue toll owed. Specifically, 87 percent of overdue toll transactions are assumed to be certified for a

notice of civil penalty by a WSDOT toll enforcement officer, with the remaining 13 percent dismissed, as noted above and consistent with other WSDOT toll facilities.

Customers receiving a NOCP will have the opportunity to remit payment for tolls and fees, or request a hearing to avoid having their motor vehicle registration withheld from renewal and/or have the amount due sent to collections. The forecast assumes that 40 percent will take action, and that 60 percent will ignore the NOCP altogether, and will ultimately be subject to hold on the renewal of their vehicle registration. This activity is not captured within the net revenue forecast process. For those customers that take action as a result of a NOCP, 43 percent are assume to remit the toll due at the Pay By Mail rate, with 85 percent assumed to pay the $40 civil penalty fee as well and the remaining 15 percent only assumed to pay the toll.

Among the 85 percent for whom both tolls and civil penalty fees are assumed to be recovered, the forecast assumes that $0.80 will be collected for every $1.00 owed. This assumption captures the possibility that an administrative law judge through the civil penalty adjudication process may reduce or forgive some of the total toll and civil penalties due. In the case of SR 520, toll revenue paid in the civil penalty process is held in a dedicated civil penalty account which can be transferred to the facility account only after legislative authorization. In the case of SR 99 the account structure and transfer requirements have not been established, and aside from a payment lag, no further time lags are assumed.

7.3.4 Civil Penalty Revenue

The revenue attributed to the $40 civil penalty is provided for informational purposes in column 27 of the T&R tables for Scenario IG-0, IG-1, and IG-2 located at the end of this section. For the WSTC adopted toll rates in Option A, civil penalty revenues have been moved into the net revenue projections as indicated in **Figure 7-1**. The $40 civil penalty fee is not assumed to escalate over the forecast horizon, and its collection is lagged by six months from the time of travel, consistent with the lag assumed for toll bill and late fee payment in the civil penalty process.

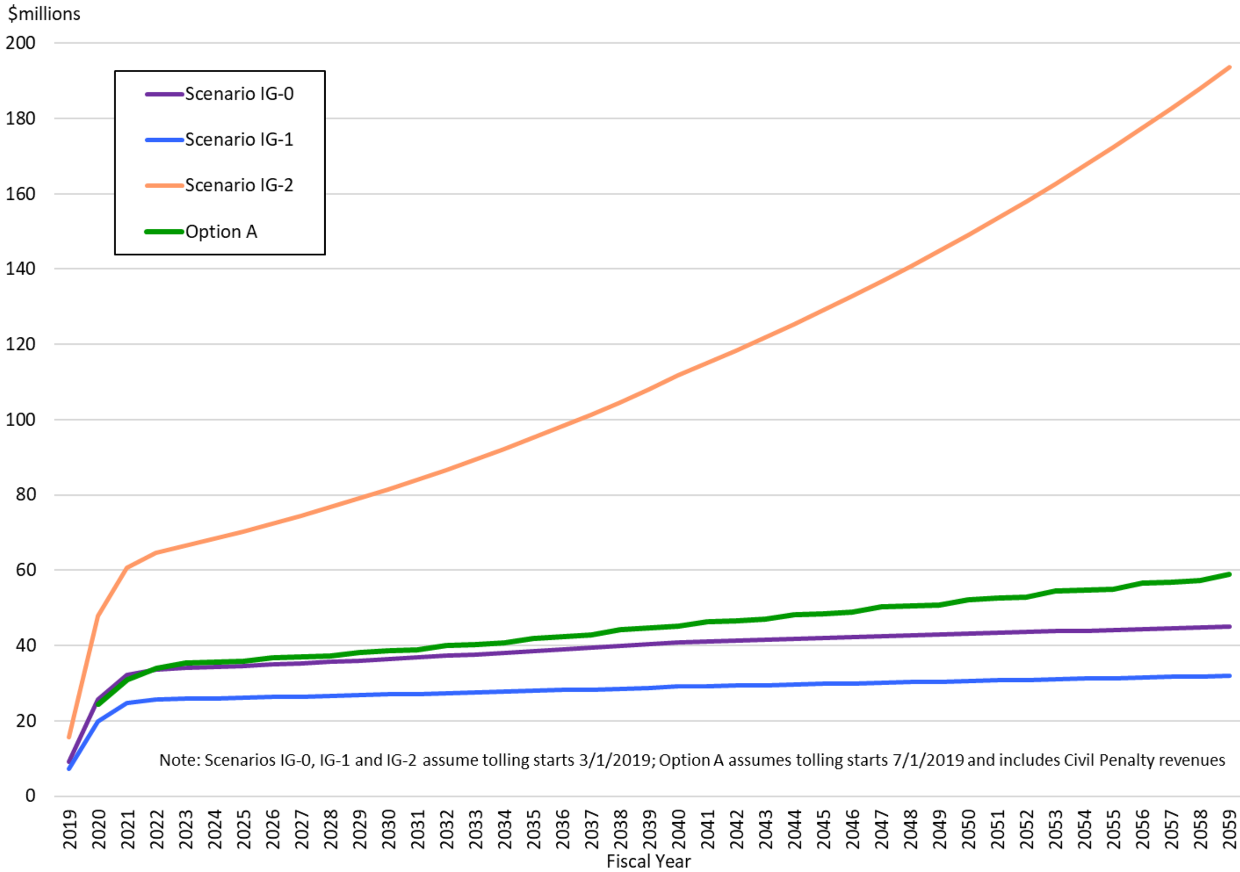
Similar to recovered toll revenue rates described in the previous section, for those customers that take action as a result of a NOCP, 43 percent are assume to remit the toll due at the Pay By Mail rate with 85 percent assumed to pay the $40 civil penalty fee as well (at an 80 percent yield), with the remaining 15 percent only assumed to pay the toll.

7.3.5 Forecast Results – Adjusted Gross Toll Revenue and Fees

The forecast for Scenario IG-0 shows a gradual increase in adjusted gross toll revenue and fees from $32 million in FY 2021, following two years of ramp-up, to $45 million at the end of the forecast horizon in FY 2059 a compound annual growth rate of approximately 0.9 percent. The lower tolls of the IG-1 scenario, which like IG-0 assume no toll rate escalation, provide 23 percent less revenue in the early years, growing to a reduction of 29 percent by the end of the forecast horizon due to differences in the growth rates of gross toll revenue potential between IG-1 and IG-0. Adjusted gross toll revenue and fees for Option A start out slightly below those of IG-0, though above those of Scenario IG-1. However, after the first 3 percent toll escalation in FY 2023, Option A surpasses Scenario IG-0, and ends up about 31 percent higher by the end of the forecast horizon as a result of the 3 percent every three years assumed toll escalation policy. Scenario IG-2, with its initially much higher toll rates and toll escalation of 2.5 percent per year intended to approximate a maximum revenue case, starts out at 88 percent higher than IG-0 in FY 2021, increasing to more than three times the adjusted gross toll revenue and fees by the end of the forecast horizon.

Figure 7-3 shows the adjusted gross toll revenue and fees by scenario, which as discussed above, represents gross toll revenue adjusted for toll payment fees and discounts, revenue not recognized, unpaid toll revenue, recaptured and recovered toll revenue, Pay By Mail rebilling fees, and transponder revenue.

Figure 7-3: Total Adjusted Gross Toll Revenue and Fees by Toll Scenario



7.4 NET TOLL REVENUE AVAILABLE FOR DEBT SERVICE

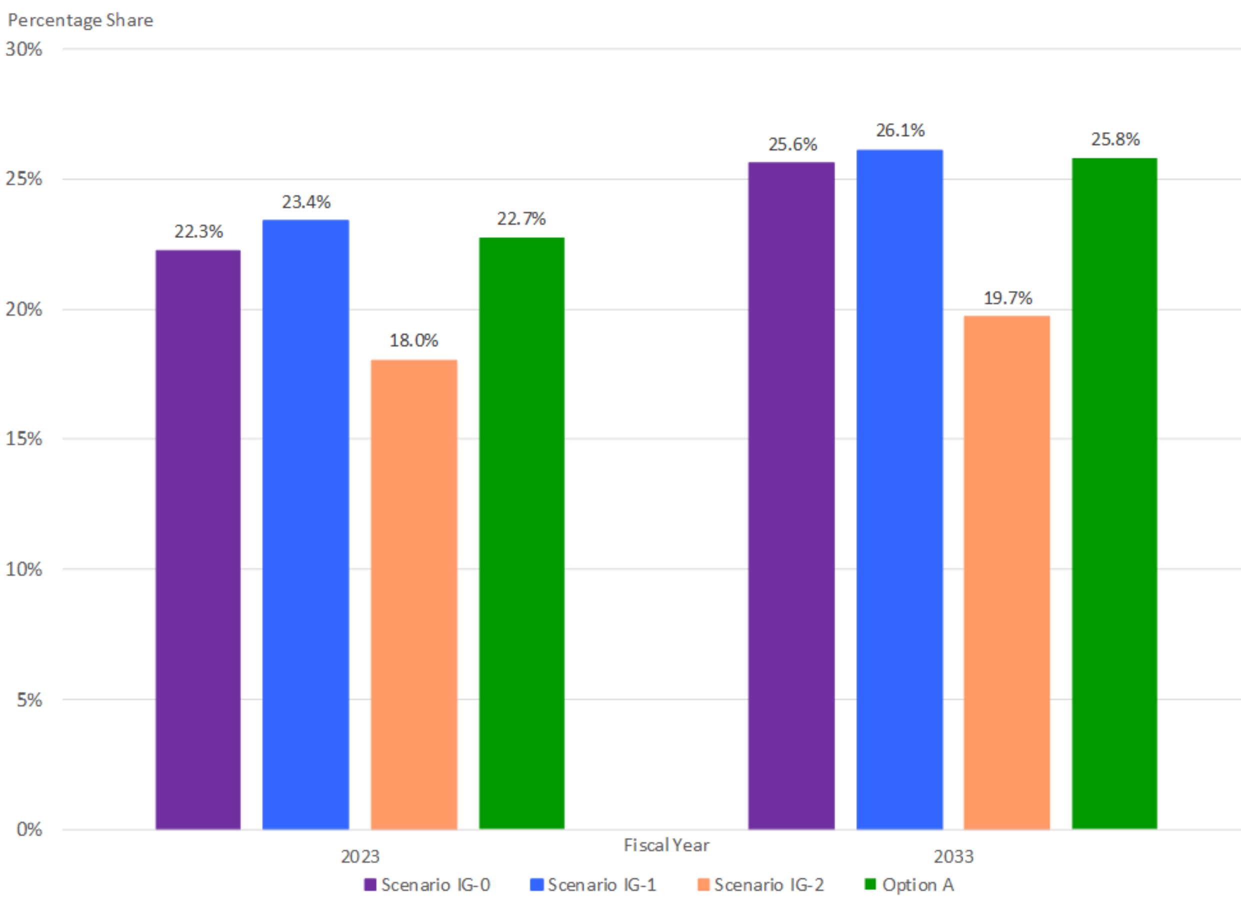
Adjusted Gross Toll Revenue and Fees are next reduced to account for credit card fees, expenditures for toll collection operating and maintenance (O&M), and routine facility O&M costs, so as to yield the annual Net Toll Revenue available for debt service and other uses such as contributions to a toll-related R&R reserve fund.

Estimates for toll collection and routine facility O&M costs were updated from the Phase 1 analysis. Scenarios IG-0, IG-1, and IG-2 were updated to reflect the latest budget assumptions and forecast values as of September 2017. Option A was updated based upon the WSDOT Toll Division Decision Package supplemental budget request from February 2028. In all four cases, the previously assumed tunnel insurance premiums have been removed and are no longer assumed to be paid from toll revenue as previously assumed in the Phase 1 analysis.

Note that certain costs or cost components are variable with the number of toll transactions (toll collection O&M including image review and printing and postage for Pay By Mail transactions) or the amount of toll revenues (credit card fees). As such, these values vary by toll scenario.

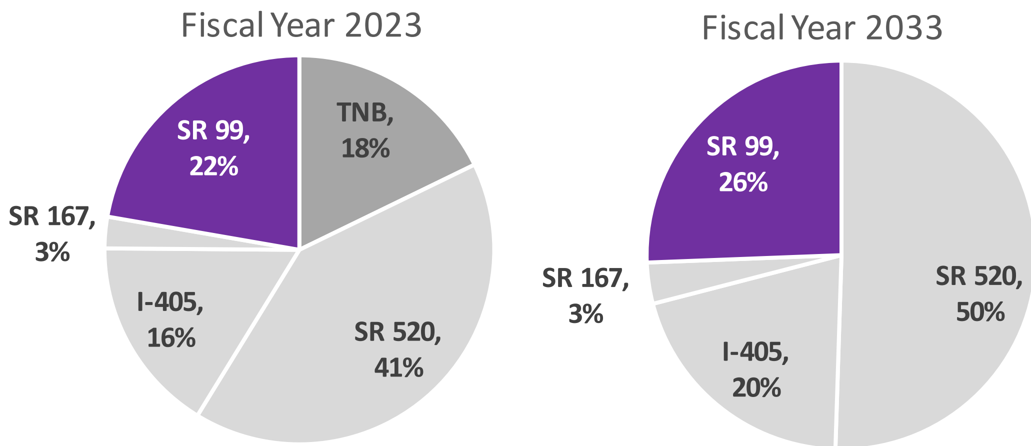
Central system-wide costs such as state operations and customer service center (CSC) vendor costs are allocated by each active facility's share of total statewide toll transactions. The share of system-wide costs allocated to SR 99 varies by toll scenario as shown in **Figure 7-4** and **Figure 7-5**. For FY 2023, the first year of post ramp-up steady-state operations, system-wide costs are shared among five toll facilities (SR 99 Tunnel, SR 520 Bridge, I-405 Bellevue to Lynnwood Express Toll Lanes, SR 167 HOT Lanes, and SR 16 Tacoma Narrows Bridge). For FY 2033, the number of facilities sharing costs will be reduced to four toll facilities, as tolls will be removed from the SR 16 Tacoma Narrows Bridge in that year.

Figure 7-4: SR 99 Share of Allocated System-Wide Toll Collection Costs by Scenario



** Transaction share based on electronic transactions, excludes TNB cash transactions in FY 2023*

Figure 7-5: SR 99 Share of Allocated System-Wide Toll Collection Costs for Scenario IG-0



** Transaction share based on electronic transactions, excludes TNB cash transactions in FY 2023*

Figure 7-6 illustrates the net toll revenue excluding civil penalty revenues and costs as well as prior to considering any toll contributions to R&R costs for each of the four toll scenarios. While costs are assumed to escalate to keep pace with general inflation for all scenarios, toll rates are assumed to escalate on pace with general inflation only for IG-2. Toll rates for Option A, which are assumed to escalate by 3 percent every third year, would lag general inflation, which is projected at 2.5 percent per year or a compounded 7.7 percent over three years. Toll rates for scenarios IG-0 and IG-1 are assumed to remain constant without any escalation throughout the forecast period. With unchanging toll rates in scenarios IG-0 and IG-1, the effect of traffic growth on revenues is not sufficient to keep pace with escalating costs, such that once ramp-up is complete, net revenue declines over most of the forecast period. For scenario IG-1, costs are projected to exceed gross toll revenue by 2056 with no change in nominal tolls. However, for scenario IG-2, toll revenue growth will continue to outpace costs throughout the forecast period, resulting in growing net revenues as well. Under Option A, the combination of traffic growth and 3 percent toll escalation every three years is sufficient to keep net revenues relatively flat over the forecast horizon, as shown in **Figure 7-6.**

7.4.1 Credit Card Fees

Credit card fees are estimated as a percentage of applicable gross toll revenues, inclusive of toll payment fees and discounts, and less uncollectible revenues. It is assumed that 92 percent of such revenues will be collected via credit or debit card, and thus applicable for vendor processing fees. Based on toll operation experience on existing WSDOT facilities through FY 2017, the bank card fee rate is assumed to be 2.2 percent. An additional factor of 1.02 is also applied to this fee revenue calculation to capture fees paid on account refunds. The share of applicable revenue and the bank card fee rates are assumed to remain constant throughout the forecast horizon.

7.4.2 Toll Collection O&M – State Operations Costs

The WSDOT Toll Division currently operates four toll facilities: the SR 520 Bridge; the SR 16 Tacoma Narrows Bridge (TNB); the I-405 Express Toll Lanes between Bellevue and Lynwood; and the SR 167 HOT Lanes. The Toll Division is responsible for general management, vendor oversight,

marketing, information technology (IT), pass through of out-of-state license plate lookup costs, and payment of the printing and postage costs associated with Pay By Mail transactions through an inter-agency agreement with the Department of Enterprise Services (DES).

Normal salary and benefits associated with state full time equivalent employees (FTEs) are broken up into three primary categories of labor that represent system-wide costs allocated to each facility based on the share of total transactions:

- Centralized toll operation, management, and administrative activities (strategic direction and planning, additional government relations, financial compliance and budgeting, traffic and revenue analysis, toll rate setting, and payroll and human resource management).
  - This consists of 2 FTEs for the WSDOT Toll Division Assistant Secretary and executive assistant and 6.5 FTEs for administrative, policy, and strategic direction and planning staff.
- Finance and program management, government relations, CSC operations, and WSDOT Headquarters Accounting and Financial Services (AFS) group support, program management activities, communications, and accounting, audit, and contracting services.
  - This consists of a set central 32 FTEs attributed to the existing four toll facilities and an incremental 4 FTEs with the addition of SR 99.
- Based on SR 99's share of system-wide transactions, approximately 10 FTEs are allocated to the facility during the preliminary budget forecast period through FY 2021. After the budget period, salary and benefit cost increases are largely driven by changes in transaction shares, the removal of TNB from the assumed toll system in FY 2033, and assumed inflationary increases in compensation.

In both the near and longer-term forecasts, current salaries and wages are escalated by 2.5 percent per year to account for average inflationary increases in compensation over time.

In addition to costs associated with salaries and wages, state operating costs includes the following items:

- Benefits – assumed to be 40 percent of salaries and wages;
- Personal services/consulting fees – related to toll operations, technical oversight, and forecasting;
- Offices supplies and materials – standard cost of $500 per year per FTE with 2.5 percent escalation;
- Rent – standard cost of $61 per square foot per year, assuming 153 square feet per FTE with 10 percent escalation every 5 years;
- Printing and postage – standard cost of $0.63 per toll bill mailing inclusive of materials and bulk postage rate, consumables and other mailing costs not associated with toll bills is also included with an additional cost of $0.02 per mailing for consumables. Printing and postage costs are escalated by 2.5 percent per year;
- Out of state license plate lookup – attributed to 9 percent of readable license plates with valid registration and owner information that require an out of state license plate lookup. Lookup costs are assumed to be $1.25 per plate inquiry in FY 2019 based on current vendor contract agreements, and reduced to $0.75 per plate with escalation in FY 2020

when the assumed new vendor contract is place. Lookup rates are assumed to escalate by 2.5 percent per year after FY 2019;

- Computers and equipment – standard cost of $5,000 per year per FTE with 2.5 percent escalation per year;
- Phone and communications, including marketing – total allocated cost of approximately $115,000 per year with 2.5 percent escalation per year;
- Vehicle operations – allocated cost for the operation and maintenance of 2 vehicles at approximately $4,000 per year plus operations and parking with 5 percent escalation per year;
- Record retention – includes WSDOT time to copy, catalog, and prepare documents for archiving, coordination with staff to retrieve files, organization of files once received, paper and organizational supplies, etc. with a standard cost of approximately $6,000 per year with 10 percent escalation every 2 years; and
- Miscellaneous goods and services – includes office equipment repairs and other small items incurred from operations with 2.5 percent escalation per year.

7.4.3 Toll Collection O&M – Customer Service Center Vendor Costs

Customer service center vendor contract costs have been forecasted for both the CSC software systems and operations components, and these system-wide costs are allocated to SR 99 based on its share of total transactions. The CSC is responsible for processing toll transactions, collecting toll revenue, maintaining customer accounts, and interfacing with customers via telephone and at *Good To Go!* walk-in centers. Currently, the CSC vendor, Electronic Transaction Consultants Corporation (ETCC), is responsible for providing the system that processes toll transactions for payment and providing customer service center operations. ETCC's existing contract was extended to cover CSC systems and operations through the completion of the next procurement cycle, anticipated in FY 2019. Once the existing contract expires, about the same time as toll operations are set to commence on SR 99, subsequent years' CSC cost forecast values are based on a model that provides a somewhat higher projection, based on a bottom-up system-wide estimate of resource requirements at current market rates to provide the various CSC systems software and operating functions. The CSC cost forecasts assumed for SR 99 are consistent with having separate vendors for systems software and operations functions, plus the addition of a five percent risk contingency.

The labor and associated cost requirements are based on the total number of system transactions, which are then allocated across the operating facilities by their proportional transaction shares. Total CSC systems and operations costs are estimated on a transaction basis with an initial cost assumption of approximately $0.20 per transaction which covers associated FTEs, operations, and equipment. CSC costs are assumed to escalate by 2.5 percent per year.

7.4.4 Toll Collection O&M – Roadway Toll Systems Vendor Costs

Roadway Toll Systems (RTS) include all equipment and software required to identify a toll transaction and transmit data about that transaction to the customer service center for processing. Sometimes referred to as "lane systems," this equipment includes transponder readers, cameras, and other communication devices that need regular maintenance to ensure the system is functioning properly.

RTS operations and maintenance activities are performed by a private vendor, in conjunction with WSDOT operations and maintenance staff. The vendor contract specifies requirements for ongoing maintenance of the toll collection equipment through the contract period. The vendor contract is a 10-year system-wide RTS contract with separate O&M costs estimates specific to each facility. WSDOT will perform any necessary maintenance to equipment gantries or other roadside equipment not covered by the RTS vendor. After the RTS system-wide vendor contract expires, the state will have the option to re-bid the contract or assume responsibility for all RTS maintenance functions. Examples of these duties include:

- Realigning / recalibrating cameras and transponder readers;
- Cleaning camera lenses;
- Maintaining equipment data connections; and
- Monitoring / auditing equipment performance.

SR 99 RTS costs are based on preliminary values estimated by WSDOT based upon the same vendor's costs for other WSDOT facilities over the 10-year vendor contract period. Subsequent 10-year vendor contract RTS costs are estimated by averaging the first contract estimates and escalating them by 2.5 percent per year, assuming that a new RTS vendor will be procured every 10 years.

7.4.5 Toll Collection O&M – Transponder Purchase and Inventory Costs

Transponder purchase, inventory, and distribution costs are estimated as system activities, with an appropriate share allocated to SR 99, including any credit card fees associated with WSDOT direct sales not involving a third-party retailer. The forecast assumes that Flex Pass transponders (declarable tags), which will allow users to switch the transponder to HOV exemption status for use on the I-405 express toll lanes (and potentially SR 167 in the future), will be purchased by users of other facilities, including SR 99. Transponder purchase and inventory costs include an additional $1.25 million in FY 2019 to account for increased transponder purchases for the six months prior and after the opening of the facility. Transponder costs through FY 2027 correspond to detailed model results provided by Toll Division that evaluate costs by transponder type, sales channel, and projected sales volume. After FY 2027, transponder purchase and inventory costs are inflated based on the forecasted growth in transponder toll transactions. One half of the transponders are assumed to be purchased directly from WSDOT at a CSC walk-in location or online using credit cards, for which WSDOT is assumed to incur a 2.2 percent credit card fee.

The costs associated with special incentives or other programs to initially market transponders to SR 99 customers have not been assumed as expenditures funded from toll revenues, and no decisions have yet been made regarding any such incentives or programs for SR 99.

7.4.6 Civil Penalty Adjudication and Collection Costs

As with the civil penalty revenues, the costs of adjudication and collection of the $40 civil penalty for delinquent toll bills is provided for informational purposes in column 27 of the T&R tables for Scenarios IG-0, IG-1 and IG-2 located at the end of this section. For the WSTC adopted toll rates in Option A, civil penalty collection costs have been moved into the net revenue projections as indicated in **Figure 7-1**. The civil penalty cost projections were provided by WSDOT using current assumptions for NOCP processing (see section 7.3.4) and civil penalty payment rates, and are understood to be conservatively high estimates going forward. It is likely that there will be economies of scale in the collection of the fees with changing trends over time that are not reflected in the current civil penalty cost projections.

7.4.7 Routine Facility O&M Costs

The limits for the tunnel project facility O&M cost estimates extend from the South Royal Brougham overcrossing of SR 99 just south of the south portal in downtown Seattle, to the Mercer Street crossing beyond the portal at the north end. Within the roadway area between these two endpoints, project components for which O&M activities are assumed to be paid from tolls include the bored tunnel and its systems, the cut-and-cover tunnel end sections, the tunnel portal road connections to surface streets, and the north and south tunnel operations buildings. Routine annual O&M costs include the following items:

- Electrical & mechanical service power and utility charges – annual cost of electrical power, communications, water, sewer, and other miscellaneous utility charges and fees
- Staffing for O&M – 34 person operations full-time staff including 17.5 FTEs for mechanical, electrical, and electronic systems, 9 FTEs for roadway maintenance, 2 FTEs for operators, 1 FTE for incidents response team (IRT), 1 FTE mechanic, 1 FTE bridge preservation inspections, 0.5 FTE for administrative duties, and 1 FTE for network functions.
- Outside Services: vendor representatives and inspection engineers – vendor representatives and engineers to perform inspections and certification of equipment, specialty systems, structures and building systems
- Support equipment and vehicles – fleet cars/fans/pickup trucks, traffic control trucks, aerial truck, scissors lift, tunnel washer, forklifts, carts, collies, load banks, lane closure signs and equipment
- Other: maintenance agreements, consumables, lamps, supplies – annual cost allowance for maintenance service agreements such as janitorial, and landscaping; consumable materials; lamps and filters; office and maintenance supplies and incidental costs

All facility O&M costs are estimated in 2016 dollars and escalated by WSDOT cost indices to derive year of expenditure dollars.

7.4.8 Forecast Results – Net Toll Revenue

The Phase 2 forecast for net toll revenues for scenario IG-0 is $707 million over the forecast horizon, with annual net revenue peaking in FY 2031 at $20 million before gradually declining as slower traffic growth combined with assumed static toll rates begin to lose ground to escalating O&M costs. By the end of the forecast horizon in FY 2059, projected net revenue has declined to $12 million.

Interestingly, the forecast horizon net toll revenue for Option A is also $707 million. While Option A has slightly lower initial net toll revenues, the 3% toll escalation every three years contributes to a small amount annual growth through FY 2044, resulting higher net revenues in the outer years than Scenario IG-0.

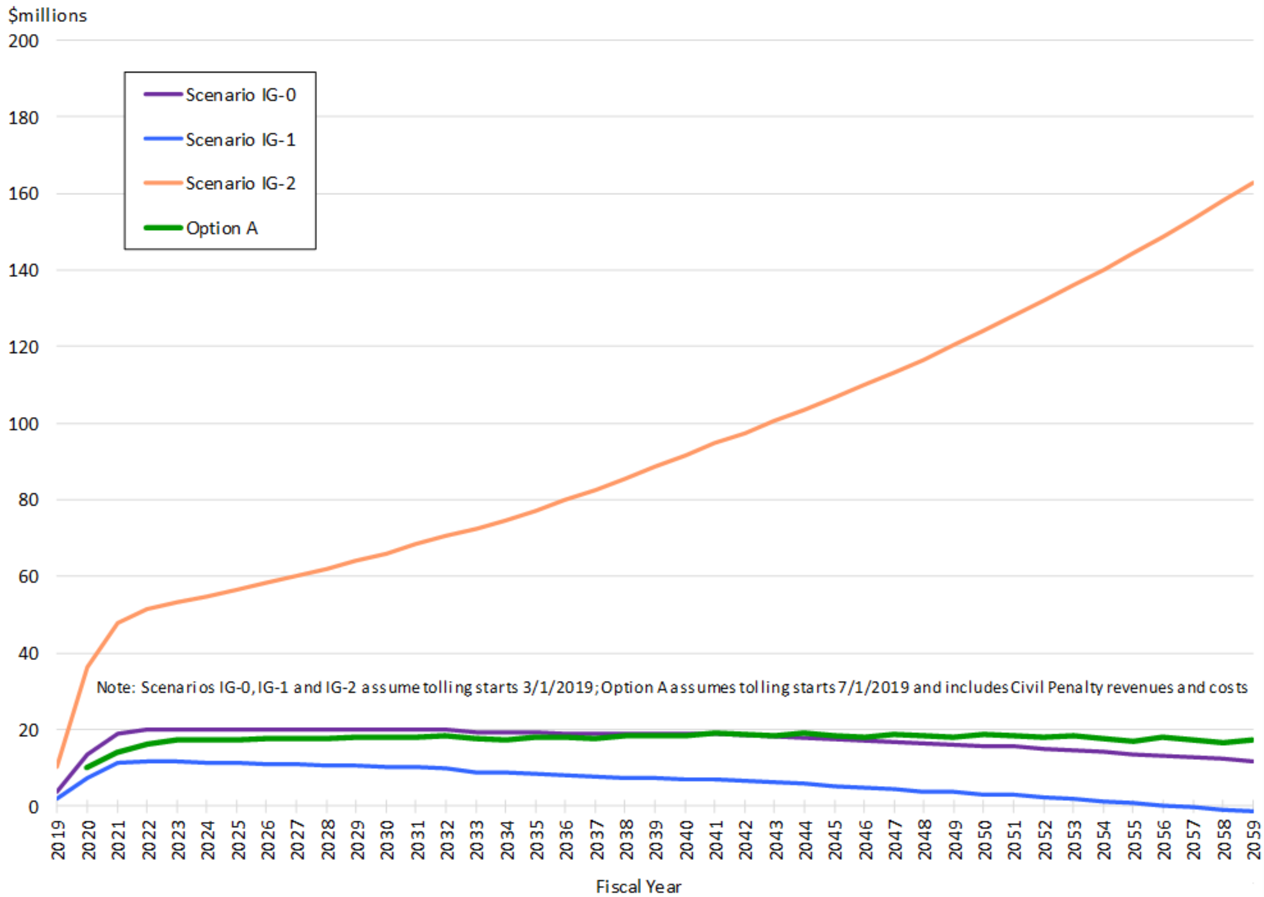
The net revenue forecast for Scenario IG-1 with its lower tolls total $263 million, or $444 million (63 percent) lower over the forecast horizon compared to Scenario IG-0. For Scenario IG-1, rising costs overtake the revenue generated with its low and static toll rates, leading to negative net revenues (net loss) starting in FY 2057.

In contrast, the results for revenue maximizing Scenario IG-2 are $3.8 billion, or $3.1 billion higher over the forecast period compared to scenario IG-0 and Option A. This is attributed not only to Scenario IG-0's higher initial toll rates, but also to its steady toll escalation of 2.5 percent per year.

While Scenarios IG-0 and IG-1 provide a useful analytical framework for financial planning, from the standpoint of ensuring that toll revenues are sufficient to cover operating costs and/or to avoid peak period congestion, it is unlikely that the Washington State Transportation Commission would not increase tolls at some point, even modestly, over 40 years. Indeed, the Option A initial toll rates were adopted by the Commission under the assumption that they would increase by 3 percent every three years, with the first such increase in FY 2023.

Figure 7-6 illustrates the net revenue forecast trends for each of the four scenarios excluding the effects of civil penalty revenues and costs as well as any toll-funded contributions to R&R costs. Scenario IG-2 net revenues exhibit steady growth as a result of the combined effects of traffic growth and 2.5 percent annual toll escalation outpacing inflationary and volume-driven growth in O&M costs. Option A exhibits a nearly flat net revenue trend with its more modest toll escalation and traffic growth just offsetting increases in O&M costs. In contrast, projected net revenues under both IG-0 and IG-1 eventually decline over time, due to costs escalating at higher rates than traffic and corresponding revenue. Nonetheless, IG-0 and IG-1 net revenues are projected to remain positive over the forecast horizon with the exception of the final few years under IG-1.

Figure 7-6: Total Net Toll Revenue Projections by Toll Scenario



7.5 PERIODIC R&R

In addition to routine annual O&M costs associated with the facility and toll collections, major repair and replacement (R&R) activities, including capital preservation and renewal items for both the tunnel facility and toll collection systems will be necessary at periodic intervals over the forecast period. Because these costs are typically infrequent, but can be sizable, it may be necessary to establish R&R reserve accounts that are funded through annual deposits. Reserve funds would maintain a balance sufficient to meet the periodic R&R expenditure needs, while at the same time smoothing out the annual cash flows over time.

Toll collection and tunnel facility R&R costs — or contributions to reserve accounts that would pay these R&R costs — are typically treated as uses of net toll revenues rather than part of the net toll revenue definition. As such, the R&R cost forecasts herein are provided outside of net revenues as information.

For the adopted toll rates under Option A, it is assumed that net toll revenues after debt service payments would contribute to a reserve fund sized to pay for periodic toll collection R&R costs. Net toll revenues may also be able to help pay for tunnel facility R&R costs; however, at this time, facility R&R costs are not assumed to be funded from tolls.

7.5.1 Periodic Toll Equipment and CSC R&R Costs

Toll-related R&R costs include the periodic repair, rehabilitation, and replacement of the RTS hardware and equipment located in the roadway at the toll collection point. In addition to hardware and equipment, the R&R cost forecast includes SR 99's share of the system-wide administrative and technical-related costs incurred by WSDOT to periodically procure both the RTS and CSC vendor contracts as well as implement and test new systems software and toll collection equipment hardware.

- RTS vendor R&R cost projections conservatively assume that the RTS vendor and entire RTS system will be replaced every 10 years. The periodic procurement of a state-wide RTS vendor is next scheduled to commence in FY 2024, followed by implementation and testing of each facility to allow for a smooth transition to a new vendor and/or new equipment. The first replacement of toll equipment on SR 99 is assumed to occur over FY 2018-2019, and at ten-year intervals thereafter.

  WSDOT state-wide RTS Procurement costs are assumed to be $2.7 million (2016 $s), with allocation to individual facilities calculated using the total number of active toll facilities rather than by the number of toll collection points, in order to avoid concerns of over-allocation of primarily fixed costs to the I-405 Express Toll Lanes and the SR 167 HOT lanes, each with multiple toll points. The forecast assumes an equal distribution of RTS procurement costs across facilities, one-fifth or 20 percent in FY 2019 with the inclusion of the SR 99 Tunnel, assumed to be paid with capital funds, and one-fourth starting in FY 2033 with removal of tolls on TNB, assuming no additional toll facilities are added over the forecast period (projects in planning but not yet authorized have been excluded). The costs for the last procurement cycle are omitted as the benefits from that vendor procurement would occur beyond the FY 2059 forecast horizon.

  RTS equipment replacement and implementation and testing, spare parts, network equipment, toll rate signs, integration, and transition and coordination support are specific to SR 99. The total estimated cost for all RTS activities is $3.2 million (2016 $s) for each 10-year replacement cycle.

- Periodic system-wide CSC vendor(s) procurement costs are allocated across the four existing facilities plus SR 99 starting with the current round of vendor procurement, assumed to be paid from capital funds for SR 99s initial share. In addition, tolls are assumed to be removed from the Tacoma Narrows Bridge at the end of FY 2032, thus removing it from the cost allocation starting with FY 2033, with no additional toll facilities currently assumed to come online over the forecast period. Procurement costs are allocated based on each facility's forecasted toll transactions in the years the costs are projected to be incurred, with the exception of the first procurement cycle anticipated to be competed in FY 2020. For this first procurement cycle, ten year totals of forecasted transactions (FYs 2020-29) for the existing four facilities (SR 520 Bridge, Tacoma Narrows Bridge, SR 167 HOT lanes, and I-405 ETLs between Bellevue and Lynnwood) plus the SR 99 transactions were used to calculate the facility allocation shares.

  System-wide costs related to the first cycle of CSC systems and operations vendor procurements are assumed to be $28 million (2016 $s), of which $1.2 million is for the CSC vendors transition and physical facility upgrades, plus the costs for physically moving WSDOT into a new facility and any associated lease improvements. Any such future transition costs are assumed to be captured within the recurring procurement costs noted below. Of the remaining $26.8 million, $22.4 million is for systems procurement and $2.3 million is for a data warehouse component of systems vendor procurement, both of which are assumed to have a 10-year contract duration and recurrence cycle. The CSC operations vendor procurement is estimated at $2.2 million and is assumed to have a 7-year contract duration and recurrence cycle. Overall, the CSC systems and operations vendor procurement costs include system and operations RFPs development, vendor solicitation, start-up, transition support, development, design and installation, and a data warehouse (for systems). The underlying costs for the periodic CSC vendor procurements are assumed to escalate at 2.5 percent per year.

As noted above, toll collection R&R costs are assumed to be a use of net toll revenues via contributions to a reserve account that would pay these R&R costs as they arise.

7.5.2 Periodic Facility R&R Costs

Periodic facility R&R costs are developed, reviewed, and validated by SR 99 project office staff and WSDOT Toll Division staff. Consistent with facility O&M costs, the project limits for facility R&R cost estimates range from the South Royal Brougham overcrossing of SR 99 at the south end of downtown Seattle, to the Mercer Street structure at the north end. Within the defined area, costs are projected to cover the single bored tunnel with cut-and-cover tunnel end sections, portal road connections to surface streets, and north and south tunnel operations buildings. Periodic R&R costs include the following items:

- Tunnel systems – including but not limited to replacement of portal and ventilation fans, fire dampers, fire protection systems, other HVAC, electrical power substations, emergency generators, lighting and wiring, ITS conduit and cabling, emergency telephones, CCTV, dynamic and fixed message signs, and traffic gates;
- Tunnel structures – including PCC paving, striping, sealing, and stairwell doors; and
- Portal buildings – including yard improvements, various interior finishes, exterior building (painting, roofing, etc.), elevators, MEP services.

All costs are estimated in annual 2016 dollars and escalated by the Construction Index maintained by the state per year to the year of expenditure based on each item's replacement schedule through the forecast horizon.

As noted previously, periodic tunnel facility R&R costs are not assumed to be funded from tolls at this time.

7.6 NET REVENUE TABLES

Traffic and revenue tables showing annual transactions, gross revenues, and net revenue amounts for FY 2019 through FY 2059 for the three scenarios are provided in **Figure 7-7**, **Figure 7-8, Figure 7-9**, and **Figure 7-10** in the following pages. The assumption for the tolling start date for Scenarios IG-0, IG-1, and IG-2 is March 1, 2019. Option A assumed a tolling start date of July 1, 2019 (FY 2020), which is approximately five months following the date that the tunnel is expected to open for traffic operations.

Figure 7-7: SR 99 Toll Traffic and Revenue Projections, Scenario IG-0: Financial Plan

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22a	22b	22c	22d	22	23	24	25	26	27	28
	Good To Go! Accounts			Pay By Mail / No Account				Toll Revenue Potential			Plus (Less):	Less:	Less:	Plus:		Plus:	Plus:	Plus:		Less:	[22a - 22d roll up to column 22]				Less:	Less:					
Fiscal Year	Wtd. Average Toll per PCE Transaction (one-way)[1]	Annual Tunnel Toll Transactions (millions)[2]	PCE Tunnel Volumes (millions)[3]	Wtd. Average Toll per PCE Transaction (one-way)[1]	Annual Tunnel Toll Transactions (millions)[2]	PCE Tunnel Volumes (millions)[3]	Total Toll Transactions (millions)	*Good To Go!* Pre-Paid Accounts ($ millions)[4]	Pay By Mail / No Account ($ millions)[5]	Total Gross Toll Revenue Potential ($ millions)	Toll Payment Discounts and Fees ($ millions)[6]	Revenue Not Recognized ($ millions)[7,8]	Unpaid Toll Revenue ($ millions)[9]	Recaptured Toll Revenue at Good To Go! Rates via CPR ($ millions)[10]	Subtotal: Adjusted Gross Toll Revenue Collected ($ millions)	Transponder Sales Revenue ($ millions)[11]	Pay By Mail Rebilling Fees (2nd Invoice & Later Recovery) ($ millions)[12]	Toll Revenue Recovered at Pay By Mail Rates via NOCP ($ millions)[13]	Subtotal: Adjusted Gross Toll Revenue & Fees ($ millions)	Credit Card Fees ($ millions)[14]	*Transponder Purchase and Inventory Costs ($ millions)*	*State Operations Costs ($ millions)*	*Customer Service Center (CSC) Vendor O&M Costs ($ millions)*	*Roadway Toll Systems (RTS) O&M Costs ($ millions)*	Toll Collection O&M Costs ($ millions)[15]	Routine Facility O&M Costs ($ millions)[16]	Total Net Toll Revenue Before R&R ($ millions)	Periodic Toll Equipment and CSC Repair & Replacement (R&R) Costs ($ millions)[17]	Periodic Facility Repair & Replacement (R&R) Costs ($ millions)[18]	Civil Penalty Revenue Collected from Unpaid Toll Bills ($ millions)[19]	Civil Penalty Adjudication and Collection Costs ($ millions)[20]
2019	$1.69	2.87	2.97	$3.60	0.98	1.02	**3.85**	5.02	3.66	**8.69**	0.14	(0.65)	(0.81)	0.04	**7.41**	1.41	0.26	0.06	**9.15**	(0.16)	*(1.41)*	*(1.10)*	*(0.87)*	*(0.27)*	(3.64)	(1.53)	**3.82**	-	-	0.46	(0.61)
2020	$1.69	9.34	9.67	$3.59	3.12	3.23	**12.46**	16.38	11.57	**27.95**	0.46	(1.64)	(2.66)	0.18	**24.29**	0.34	0.90	0.27	**25.80**	(0.51)	*(0.34)*	*(3.03)*	*(2.76)*	*(0.81)*	(6.93)	(4.70)	**13.65**	-	(0.01)	1.96	(1.52)
2021	$1.69	11.52	11.93	$3.59	3.72	3.85	**15.24**	20.21	13.82	**34.03**	0.56	(1.47)	(3.29)	0.31	**30.14**	0.41	1.17	0.46	**32.18**	(0.64)	*(0.41)*	*(3.59)*	*(3.09)*	*(0.74)*	(7.84)	(4.81)	**18.89**	-	-	3.38	(1.75)
2022	$1.69	12.16	12.59	$3.59	3.80	3.93	**15.96**	21.31	14.12	**35.44**	0.59	(1.50)	(3.37)	0.35	**31.50**	0.43	1.22	0.52	**33.66**	(0.66)	*(0.43)*	*(3.73)*	*(3.17)*	*(0.78)*	(8.11)	(4.93)	**19.96**	-	(0.01)	3.79	(1.82)
2023	$1.69	12.40	12.84	$3.59	3.76	3.89	**16.15**	21.74	13.96	**35.70**	0.60	(1.49)	(3.33)	0.35	**31.81**	0.44	1.21	0.52	**33.99**	(0.67)	*(0.44)*	*(3.78)*	*(3.23)*	*(0.79)*	(8.24)	(5.04)	**20.03**	-	-	3.81	(1.83)
2024	$1.69	12.65	13.10	$3.59	3.71	3.85	**16.36**	22.18	13.80	**35.97**	0.60	(1.48)	(3.30)	0.35	**32.14**	0.45	1.20	0.52	**34.31**	(0.68)	*(0.45)*	*(3.84)*	*(3.30)*	*(0.83)*	(8.43)	(5.16)	**20.05**	(0.42)	(0.01)	3.78	(1.86)
2025	$1.69	12.89	13.35	$3.59	3.66	3.80	**16.56**	22.62	13.64	**36.25**	0.61	(1.47)	(3.26)	0.34	**32.47**	0.47	1.18	0.51	**34.64**	(0.68)	*(0.47)*	*(3.91)*	*(3.44)*	*(0.87)*	(8.69)	(5.27)	**19.99**	(0.90)	-	3.74	(1.89)
2026	$1.69	13.15	13.62	$3.59	3.62	3.75	**16.78**	23.08	13.47	**36.54**	0.62	(1.46)	(3.23)	0.34	**32.81**	0.48	1.17	0.51	**34.98**	(0.69)	*(0.48)*	*(3.98)*	*(3.51)*	*(0.88)*	(8.85)	(5.39)	**20.04**	(0.38)	(0.01)	3.70	(1.92)
2027	$1.69	13.41	13.89	$3.60	3.57	3.70	**16.98**	23.54	13.31	**36.85**	0.63	(1.45)	(3.19)	0.34	**33.17**	0.50	1.16	0.50	**35.33**	(0.70)	*(0.50)*	*(4.05)*	*(3.60)*	*(0.92)*	(9.07)	(5.51)	**20.06**	-	-	3.67	(1.95)
2028	$1.69	13.68	14.17	$3.59	3.54	3.67	**17.22**	24.01	13.15	**37.16**	0.64	(1.44)	(3.16)	0.33	**33.53**	0.51	1.15	0.50	**35.69**	(0.70)	*(0.51)*	*(4.13)*	*(3.72)*	*(0.97)*	(9.34)	(5.62)	**20.02**	(4.92)	(5.78)	3.63	(1.99)
2029	$1.69	13.95	14.45	$3.59	3.49	3.61	**17.44**	24.50	12.99	**37.49**	0.65	(1.43)	(3.12)	0.33	**33.91**	0.52	1.14	0.49	**36.06**	(0.71)	*(0.52)*	*(4.21)*	*(3.82)*	*(1.08)*	(9.64)	(5.74)	**19.98**	(7.74)	-	3.60	(2.05)
2030	$1.70	14.22	14.74	$3.59	3.45	3.57	**17.67**	24.98	12.83	**37.82**	0.65	(1.42)	(3.09)	0.33	**34.28**	0.53	1.13	0.49	**36.43**	(0.72)	*(0.53)*	*(4.31)*	*(3.96)*	*(1.12)*	(9.92)	(5.85)	**19.94**	(0.33)	(0.02)	3.57	(2.09)
2031	$1.70	14.51	15.03	$3.59	3.42	3.54	**17.92**	25.49	12.70	**38.18**	0.66	(1.41)	(3.07)	0.32	**34.69**	0.55	1.12	0.48	**36.84**	(0.73)	*(0.55)*	*(4.41)*	*(4.07)*	*(1.03)*	(10.05)	(5.97)	**20.10**	(0.09)	-	3.54	(2.13)
2032	$1.70	14.80	15.34	$3.60	3.37	3.49	**18.17**	26.01	12.55	**38.55**	0.67	(1.41)	(3.03)	0.32	**35.11**	0.56	1.11	0.48	**37.26**	(0.74)	*(0.56)*	*(4.50)*	*(4.19)*	*(1.10)*	(10.34)	(6.08)	**20.10**	(0.21)	(0.02)	3.51	(2.16)
2033	$1.69	15.10	15.65	$3.60	3.32	3.44	**18.43**	26.52	12.40	**38.92**	0.68	(1.40)	(3.00)	0.32	**35.52**	0.57	1.10	0.48	**37.66**	(0.75)	*(0.57)*	*(5.10)*	*(4.70)*	*(1.12)*	(11.50)	(6.20)	**19.23**	(0.54)	(34.81)	3.47	(2.29)
2034	$1.70	15.40	15.96	$3.59	3.29	3.41	**18.69**	27.06	12.24	**39.30**	0.69	(1.39)	(2.97)	0.32	**35.95**	0.58	1.09	0.47	**38.09**	(0.75)	*(0.58)*	*(5.22)*	*(4.81)*	*(1.19)*	(11.81)	(6.31)	**19.22**	(0.67)	(0.02)	3.44	(2.32)
2035	$1.70	15.70	16.27	$3.60	3.24	3.36	**18.94**	27.60	12.10	**39.71**	0.70	(1.38)	(2.93)	0.31	**36.41**	0.59	1.08	0.47	**38.55**	(0.76)	*(0.59)*	*(5.34)*	*(4.97)*	*(1.28)*	(12.18)	(6.43)	**19.17**	(1.06)	-	3.41	(2.36)
2036	$1.70	16.03	16.61	$3.59	3.21	3.33	**19.24**	28.16	11.97	**40.12**	0.71	(1.37)	(2.91)	0.31	**36.86**	0.61	1.07	0.46	**39.00**	(0.77)	*(0.61)*	*(5.46)*	*(5.21)*	*(1.31)*	(12.59)	(6.54)	**19.10**	-	(0.02)	3.38	(2.40)
2037	$1.70	16.33	16.93	$3.60	3.17	3.29	**19.50**	28.73	11.83	**40.55**	0.72	(1.37)	(2.88)	0.31	**37.34**	0.62	1.06	0.46	**39.48**	(0.78)	*(0.62)*	*(5.59)*	*(5.40)*	*(1.39)*	(13.00)	(6.66)	**19.04**	-	-	3.35	(2.45)
2038	$1.70	16.66	17.27	$3.59	3.14	3.25	**19.80**	29.30	11.68	**40.98**	0.74	(1.36)	(2.86)	0.31	**37.81**	0.63	1.06	0.46	**39.95**	(0.79)	*(0.63)*	*(5.73)*	*(5.55)*	*(1.49)*	(13.40)	(6.78)	**18.98**	(6.88)	(17.29)	3.33	(2.49)
2039	$1.70	17.01	17.63	$3.60	3.10	3.21	**20.11**	29.90	11.55	**41.45**	0.75	(1.35)	(2.82)	0.30	**38.32**	0.65	1.05	0.45	**40.46**	(0.80)	*(0.65)*	*(5.88)*	*(5.74)*	*(1.39)*	(13.65)	(6.89)	**19.12**	(11.51)	-	3.30	(2.54)
2040	$1.70	17.34	17.97	$3.60	3.06	3.17	**20.39**	30.50	11.41	**41.90**	0.76	(1.35)	(2.80)	0.30	**38.82**	0.66	1.04	0.45	**40.96**	(0.81)	*(0.66)*	*(6.03)*	*(5.95)*	*(1.43)*	(14.07)	(7.01)	**19.07**	(1.08)	(0.02)	3.27	(2.59)
2041	$1.70	17.42	18.06	$3.61	3.07	3.18	**20.49**	30.65	11.47	**42.12**	0.76	(1.35)	(2.81)	0.30	**39.02**	0.66	1.04	0.45	**41.17**	(0.82)	*(0.66)*	*(6.20)*	*(6.11)*	*(1.32)*	(14.28)	(7.12)	**18.95**	-	-	3.26	(2.66)
2042	$1.70	17.51	18.15	$3.60	3.09	3.20	**20.60**	30.81	11.53	**42.33**	0.77	(1.36)	(2.83)	0.30	**39.21**	0.67	1.05	0.45	**41.37**	(0.82)	*(0.67)*	*(6.37)*	*(6.28)*	*(1.41)*	(14.73)	(7.24)	**18.58**	-	(0.02)	3.28	(2.73)
2043	$1.70	17.60	18.25	$3.59	3.11	3.23	**20.71**	30.97	11.58	**42.55**	0.77	(1.37)	(2.84)	0.30	**39.42**	0.67	1.05	0.45	**41.59**	(0.83)	*(0.67)*	*(6.55)*	*(6.45)*	*(1.44)*	(15.11)	(7.35)	**18.30**	-	(7.05)	3.30	(2.81)
2044	$1.70	17.69	18.34	$3.60	3.12	3.24	**20.81**	31.13	11.64	**42.77**	0.77	(1.37)	(2.85)	0.30	**39.62**	0.67	1.06	0.45	**41.81**	(0.83)	*(0.67)*	*(6.72)*	*(6.63)*	*(1.53)*	(15.55)	(7.47)	**17.96**	(0.85)	(0.02)	3.32	(2.89)
2045	$1.70	17.77	18.43	$3.60	3.13	3.25	**20.90**	31.29	11.70	**42.99**	0.78	(1.38)	(2.87)	0.31	**39.83**	0.68	1.06	0.46	**42.02**	(0.83)	*(0.68)*	*(6.92)*	*(6.85)*	*(1.64)*	(16.08)	(7.58)	**17.52**	(1.36)	-	3.33	(2.97)
2046	$1.70	17.86	18.51	$3.60	3.15	3.27	**21.01**	31.44	11.76	**43.20**	0.78	(1.39)	(2.89)	0.31	**40.02**	0.68	1.07	0.46	**42.22**	(0.84)	*(0.68)*	*(7.11)*	*(7.03)*	*(1.67)*	(16.50)	(7.70)	**17.19**	(0.49)	(0.02)	3.35	(3.06)
2047	$1.70	17.95	18.61	$3.60	3.17	3.28	**21.12**	31.61	11.83	**43.43**	0.79	(1.40)	(2.90)	0.31	**40.24**	0.68	1.07	0.46	**42.45**	(0.84)	*(0.68)*	*(7.31)*	*(7.22)*	*(1.78)*	(16.98)	(7.82)	**16.81**	(0.79)	-	3.36	(3.14)
2048	$1.70	18.05	18.71	$3.60	3.19	3.30	**21.23**	31.77	11.88	**43.65**	0.79	(1.40)	(2.91)	0.31	**40.44**	0.69	1.08	0.46	**42.66**	(0.85)	*(0.69)*	*(7.50)*	*(7.41)*	*(1.91)*	(17.51)	(7.93)	**16.38**	(8.92)	(49.50)	3.38	(3.23)
2049	$1.70	18.14	18.80	$3.60	3.20	3.31	**21.33**	31.93	11.94	**43.87**	0.79	(1.41)	(2.92)	0.31	**40.64**	0.69	1.08	0.47	**42.87**	(0.85)	*(0.69)*	*(7.71)*	*(7.62)*	*(1.78)*	(17.79)	(8.05)	**16.18**	(14.57)	-	3.40	(3.32)
2050	$1.70	18.23	18.90	$3.60	3.22	3.34	**21.45**	32.09	12.00	**44.10**	0.80	(1.42)	(2.94)	0.31	**40.85**	0.69	1.09	0.47	**43.10**	(0.86)	*(0.69)*	*(7.94)*	*(7.87)*	*(1.83)*	(18.34)	(8.16)	**15.74**	(0.55)	(0.02)	3.41	(3.42)
2051	$1.70	18.32	18.99	$3.60	3.23	3.35	**21.55**	32.26	12.06	**44.32**	0.80	(1.42)	(2.95)	0.32	**41.05**	0.70	1.09	0.47	**43.31**	(0.86)	*(0.70)*	*(8.15)*	*(8.07)*	*(1.69)*	(18.61)	(8.28)	**15.57**	-	(88.34)	3.43	(3.52)
2052	$1.70	18.40	19.08	$3.60	3.25	3.37	**21.65**	32.43	12.13	**44.56**	0.80	(1.43)	(2.97)	0.32	**41.27**	0.70	1.10	0.47	**43.54**	(0.86)	*(0.70)*	*(8.38)*	*(8.28)*	*(1.80)*	(19.16)	(8.39)	**15.13**	-	(0.02)	3.45	(3.61)
2053	$1.70	18.50	19.18	$3.61	3.26	3.38	**21.76**	32.60	12.19	**44.79**	0.81	(1.44)	(2.99)	0.32	**41.49**	0.70	1.10	0.48	**43.77**	(0.87)	*(0.70)*	*(8.61)*	*(8.49)*	*(1.84)*	(19.64)	(8.51)	**14.75**	(0.43)	-	3.46	(3.72)
2054	$1.70	18.59	19.28	$3.60	3.28	3.40	**21.87**	32.76	12.25	**45.01**	0.81	(1.45)	(3.01)	0.32	**41.69**	0.71	1.11	0.48	**43.98**	(0.87)	*(0.71)*	*(8.85)*	*(8.71)*	*(1.96)*	(20.22)	(8.62)	**14.26**	(2.04)	(0.02)	3.48	(3.82)
2055	$1.70	18.69	19.38	$3.61	3.29	3.41	**21.98**	32.93	12.31	**45.24**	0.82	(1.45)	(3.02)	0.32	**41.91**	0.71	1.11	0.48	**44.21**	(0.88)	*(0.71)*	*(9.10)*	*(9.00)*	*(2.10)*	(20.91)	(8.74)	**13.69**	(1.74)	-	3.50	(3.93)
2056	$1.70	18.77	19.46	$3.60	3.31	3.43	**22.09**	33.10	12.37	**45.47**	0.82	(1.46)	(3.03)	0.32	**42.12**	0.71	1.12	0.48	**44.44**	(0.88)	*(0.71)*	*(9.34)*	*(9.22)*	*(2.14)*	(21.42)	(8.86)	**13.28**	-	(0.02)	3.52	(4.04)
2057	$1.70	18.88	19.57	$3.60	3.33	3.45	**22.21**	33.27	12.43	**45.69**	0.83	(1.47)	(3.05)	0.33	**42.33**	0.72	1.13	0.49	**44.66**	(0.89)	*(0.72)*	*(9.62)*	*(9.46)*	*(2.19)*	(21.99)	(8.97)	**12.82**	-	-	3.54	(4.16)
2058	$1.70	18.97	19.66	$3.60	3.35	3.47	**22.31**	33.43	12.49	**45.93**	0.83	(1.48)	(3.06)	0.33	**42.55**	0.72	1.13	0.49	**44.89**	(0.89)	*(0.72)*	*(9.88)*	*(9.70)*	*(2.25)*	(22.55)	(9.09)	**12.36**	(5.71)	(21.75)	3.55	(4.28)
2059	$1.70	19.06	19.76	$3.61	3.36	3.48	**22.42**	33.61	12.55	**46.16**	0.84	(1.48)	(3.07)	0.33	**42.77**	0.72	1.14	0.49	**45.12**	(0.90)	*(0.72)*	*(10.16)*	*(9.94)*	*(2.31)*	(23.13)	(9.20)	**11.89**	(12.34)	-	3.57	(4.40)
Totals FY 2019-44		371.34	384.79		85.13	88.21	**456.47**	652.37	316.95	**969.32**	16.91	(36.16)	(76.41)	7.91	**881.57**	15.17	27.87	11.81	**936.41**	(18.51)	*(15.17)*	*(122.76)*	*(114.51)*	*(28.50)*	(280.94)	(153.60)	**483.36**	(37.58)	(65.10)	86.24	(56.11)
Totals FY 2019-59		647.51	671.11		133.84	138.71	**781.35**	1,138.87	498.85	**1,637.72**	29.00	(57.64)	(120.99)	12.66	**1,500.75**	25.66	44.35	18.90	**1,589.67**	(31.48)	*(25.66)*	*(249.34)*	*(239.39)*	*(57.37)*	(571.77)	(279.50)	**706.93**	(86.52)	(224.78)	137.96	(110.71)

Footnotes

[1] Reflects the average revenue per passenger car equivalent (PCE) based on time-of-day variable weekday and weekend toll structures.
[2] Annual volume of vehicles subject to tolls in each travel direction; includes autos and trucks.
[3] Converts trucks to a passenger car equivalent (PCE) based on axle number multipliers averaging 1.06 and 2.09 for medium and large trucks, respectively.
[4] Gross toll revenue potential from pre-paid Good To Go! accounts before any adjustments for uncollectible revenue, fees, and credits.
[5] Gross toll revenue potential from customers without established accounts before adjustments for uncollectible revenue, fees, and credits. Forecasts assume an additional toll increment of $2.00 per transaction for Pay By Mail customer transactions.
[6] Includes $0.25 per transaction fee charged for pre-paid Good To Go! Pay By Plate transactions; no annual escalation in fee. No discounts currently assumed.
[7] Inability to read the vehicle license plate due to equipment failure or image obstruction resulting in unbillable revenue.
[8] Inability to identify the vehicle owner's name and address from a readable license plate resulting in unbillable revenue.
[9] Recognized but unpaid toll revenue after 80 days (2 billing cycles) from date of travel; excludes tolls subsequently recovered from a Notice of Civil Penalty (NOCP).
[10] Initially unpaid toll revenue from a toll bill that is later recaptured after 80 days and linked to an account at the Good To Go! toll rate without civil penalty.
[11] Anticipated revenues from transponder sales; forecast values are set equal to transponder inventory purchase costs and credit card fees, as included in column 22/22a.
[12] Late payment rebilling fee of $5 per invoice (no escalation) assessed to Pay By Mail customers who don't pay first invoice; includes fees recovered from a NOCP (6 mo lag).
[13] Initially unpaid toll revenue from a toll bill that is later recovered after 80 days from a NOCP at the Pay By Mail toll rate, with or without the $40 civil penalty.
[14] Credit card fees estimated at 2.20% of applicable gross toll revenues collected via bank card; additional factor included for fees related to account refunds.
[15] Includes (a) transponder purchase/inventory costs; (b) State operations costs for toll bill printing/postage/license plate lookup, accounting, marketing, and vendor oversight; (c) Customer Service Center (CSC) vendor costs for operations and systems software; and (d) Roadway Toll Systems (RTS) O&M costs.
[16] Includes all annual facility O&M costs that are incurred on a routine basis for the roadway and tunnel systems, as revised by the SR 99 Team on 9/21/16.
[17] Includes periodic RTS and CSC vendor re-procurement costs (except FY 2019-20), system testing and acceptance, as well as periodic RTS equipment replacement costs.
[18] Includes facility repair and replacement (R&R) costs for the roadway and tunnel systems and related periodic capital replacement.
[19] $40 civil penalty revenue collected from a portion of the Notice of Civil Penalty statements sent to Pay By Mail customer for toll bills unpaid after 80 days.
[20] Includes adjudication costs for administrative law judges, processing, credit card fees, and collection of tolls / fees from customers of unpaid toll bills that are mailed NOCPs.

General Notes

– Revised Traffic and Gross Revenue Projections prepared by Stantec, dated 4/14/2017.
– Scenario IG-0 assumes one-way, weekday toll rates of $2.50 from 3-6 PM; $1.75 from 6-9 AM; 5-6 AM, 9 AM-3 PM, and 6-11 PM; and $1.00 from 11 PM-5 AM. Weekend tolls are $1.00 at all times.
– Scenario IG-0 excludes any toll escalation over time.
– Some FY 2019-21 O&M and R&R cost values may differ from the WSDOT proposed decision package budget due in part to inclusion of cost escalation.
– Table values include more precision than displayed.

Figure 7-8: SR 99 Toll Traffic and Revenue Projections, Scenario IG-1: Low Diversion

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Fiscal Year	*Good To Go!* Accounts: Wtd. Average Toll per PCE Transaction (one-way)[1]	*Good To Go!* Accounts: Annual Tunnel Toll Transactions (millions)[2]	*Good To Go!* Accounts: PCE Tunnel Volumes (millions)[3]	Pay By Mail / No Account: Wtd. Average Toll per PCE Transaction (one-way)[1]	Pay By Mail / No Account: Annual Tunnel Toll Transactions (millions)[2]	Pay By Mail / No Account: PCE Tunnel Volumes (millions)[3]	**Total Toll Transactions (millions)**	Toll Revenue Potential: *Good To Go!* Pre-Paid Accounts ($ millions)[4]	Toll Revenue Potential: Pay By Mail / No Account ($ millions)[5]	**Total Gross Toll Revenue Potential ($ millions)**	Plus (Less): Toll Payment Discounts and Fees ($ millions)[6]	Less: Revenue Not Recognized ($ millions)[7,8]	Less: Unpaid Toll Revenue ($ millions)[9]	Plus: Recaptured Toll Revenue at Good To Go! Rates via CPR ($ millions)[10]	**Subtotal: Adjusted Gross Toll Revenue Collected ($ millions)**
2019	$1.08	3.09	3.18	$2.96	1.07	1.10	**4.16**	3.43	3.25	**6.68**	0.15	(0.56)	(0.71)	0.03	**5.59**
2020	$1.08	10.07	10.36	$2.96	3.36	3.45	**13.43**	11.17	10.24	**21.41**	0.49	(1.41)	(2.33)	0.13	**18.29**
2021	$1.08	12.40	12.76	$2.96	4.01	4.12	**16.41**	13.76	12.20	**25.96**	0.61	(1.25)	(2.88)	0.22	**22.64**
2022	$1.08	13.06	13.43	$2.96	4.08	4.20	**17.14**	14.47	12.43	**26.90**	0.63	(1.28)	(2.94)	0.24	**23.55**
2023	$1.08	13.27	13.65	$2.97	4.02	4.13	**17.28**	14.73	12.26	**26.99**	0.64	(1.27)	(2.90)	0.25	**23.70**
2024	$1.08	13.50	13.90	$2.97	3.96	4.07	**17.46**	14.98	12.08	**27.06**	0.64	(1.26)	(2.86)	0.24	**23.83**
2025	$1.08	13.74	14.14	$2.96	3.91	4.02	**17.64**	15.25	11.90	**27.15**	0.65	(1.24)	(2.83)	0.24	**23.97**
2026	$1.08	13.98	14.39	$2.97	3.84	3.95	**17.82**	15.52	11.73	**27.25**	0.66	(1.23)	(2.78)	0.24	**24.13**
2027	$1.08	14.22	14.64	$2.95	3.80	3.91	**18.02**	15.79	11.56	**27.35**	0.67	(1.22)	(2.75)	0.23	**24.28**
2028	$1.08	14.47	14.90	$2.96	3.74	3.85	**18.20**	16.07	11.40	**27.47**	0.67	(1.20)	(2.71)	0.23	**24.46**
2029	$1.08	14.72	15.16	$2.96	3.69	3.80	**18.41**	16.35	11.23	**27.58**	0.68	(1.19)	(2.68)	0.23	**24.62**
2030	$1.08	14.98	15.43	$2.96	3.63	3.74	**18.60**	16.65	11.07	**27.72**	0.69	(1.18)	(2.64)	0.23	**24.81**
2031	$1.08	15.23	15.69	$2.96	3.59	3.69	**18.82**	16.93	10.92	**27.85**	0.70	(1.17)	(2.61)	0.22	**24.99**
2032	$1.08	15.50	15.97	$2.96	3.52	3.63	**19.02**	17.22	10.76	**27.98**	0.70	(1.16)	(2.57)	0.22	**25.18**
2033	$1.08	15.76	16.24	$2.96	3.47	3.58	**19.23**	17.53	10.60	**28.14**	0.71	(1.15)	(2.54)	0.22	**25.38**
2034	$1.08	16.04	16.53	$2.96	3.43	3.53	**19.47**	17.84	10.45	**28.29**	0.72	(1.14)	(2.51)	0.22	**25.58**
2035	$1.08	16.32	16.82	$2.97	3.37	3.47	**19.68**	18.15	10.30	**28.45**	0.73	(1.13)	(2.47)	0.21	**25.80**
2036	$1.08	16.60	17.12	$2.96	3.33	3.43	**19.93**	18.48	10.15	**28.63**	0.74	(1.12)	(2.44)	0.21	**26.02**
2037	$1.08	16.89	17.42	$2.96	3.28	3.38	**20.17**	18.80	10.00	**28.80**	0.75	(1.11)	(2.41)	0.21	**26.25**
2038	$1.08	17.18	17.72	$2.96	3.23	3.34	**20.41**	19.14	9.87	**29.00**	0.76	(1.10)	(2.38)	0.21	**26.49**
2039	$1.08	17.48	18.03	$2.95	3.19	3.29	**20.67**	19.47	9.72	**29.19**	0.77	(1.09)	(2.35)	0.21	**26.73**
2040	$1.08	17.80	18.36	$2.95	3.14	3.24	**20.94**	19.82	9.57	**29.40**	0.78	(1.08)	(2.31)	0.20	**26.98**
2041	$1.08	17.88	18.44	$2.96	3.15	3.25	**21.03**	19.91	9.63	**29.54**	0.78	(1.08)	(2.33)	0.20	**27.11**
2042	$1.08	17.96	18.53	$2.96	3.17	3.27	**21.14**	20.02	9.67	**29.69**	0.79	(1.09)	(2.34)	0.20	**27.25**
2043	$1.08	18.06	18.63	$2.95	3.19	3.30	**21.25**	20.12	9.72	**29.84**	0.79	(1.10)	(2.35)	0.20	**27.38**
2044	$1.08	18.14	18.72	$2.96	3.20	3.31	**21.35**	20.23	9.78	**30.00**	0.79	(1.10)	(2.36)	0.21	**27.54**
2045	$1.08	18.24	18.81	$2.96	3.22	3.32	**21.45**	20.32	9.82	**30.14**	0.80	(1.11)	(2.37)	0.21	**27.67**
2046	$1.08	18.33	18.91	$2.96	3.24	3.34	**21.57**	20.43	9.87	**30.30**	0.80	(1.11)	(2.39)	0.21	**27.81**
2047	$1.08	18.42	19.00	$2.95	3.26	3.36	**21.67**	20.54	9.92	**30.46**	0.81	(1.12)	(2.40)	0.21	**27.96**
2048	$1.08	18.51	19.10	$2.96	3.27	3.37	**21.78**	20.64	9.97	**30.60**	0.81	(1.12)	(2.41)	0.21	**28.09**
2049	$1.08	18.60	19.19	$2.96	3.28	3.38	**21.88**	20.74	10.02	**30.76**	0.81	(1.13)	(2.42)	0.21	**28.24**
2050	$1.08	18.70	19.29	$2.96	3.30	3.40	**22.00**	20.85	10.07	**30.93**	0.82	(1.13)	(2.44)	0.21	**28.38**
2051	$1.08	18.78	19.38	$2.96	3.32	3.42	**22.10**	20.96	10.13	**31.09**	0.82	(1.14)	(2.45)	0.21	**28.53**
2052	$1.08	18.89	19.48	$2.95	3.34	3.45	**22.23**	21.06	10.17	**31.23**	0.83	(1.15)	(2.46)	0.21	**28.66**
2053	$1.08	18.97	19.57	$2.97	3.34	3.45	**22.31**	21.17	10.23	**31.40**	0.83	(1.15)	(2.47)	0.21	**28.82**
2054	$1.08	19.08	19.68	$2.96	3.36	3.47	**22.44**	21.28	10.28	**31.55**	0.83	(1.16)	(2.49)	0.22	**28.95**
2055	$1.08	19.17	19.77	$2.96	3.38	3.49	**22.55**	21.38	10.32	**31.70**	0.84	(1.16)	(2.50)	0.22	**29.10**
2056	$1.08	19.27	19.88	$2.96	3.40	3.51	**22.67**	21.49	10.38	**31.87**	0.84	(1.17)	(2.51)	0.22	**29.25**
2057	$1.08	19.36	19.97	$2.95	3.43	3.53	**22.79**	21.60	10.43	**32.03**	0.85	(1.18)	(2.52)	0.22	**29.40**
2058	$1.08	19.47	20.08	$2.96	3.44	3.54	**22.90**	21.72	10.49	**32.21**	0.85	(1.18)	(2.53)	0.22	**29.56**
2059	$1.08	19.55	20.17	$2.97	3.45	3.55	**23.00**	21.82	10.54	**32.36**	0.86	(1.19)	(2.55)	0.22	**29.70**
Totals FY 2019-44		388.31	400.14		89.35	92.05	**477.66**	431.83	272.47	**704.30**	17.70	(29.90)	(64.98)	5.46	**632.58**
Totals FY 2019-59		671.64	692.42		139.35	143.63	**810.99**	747.83	425.11	**1,172.94**	30.10	(47.09)	(101.89)	8.66	**1,062.72**

1	17	18	19	20	21	22a	22b	22c	22d	22	23	24	25	26	27	28
Fiscal Year	Plus: Transponder Sales Revenue ($ millions)[11]	Plus: Pay By Mail Rebilling Fees (2nd Invoice & Later Recovery) ($ millions)[12]	Plus: Toll Revenue Recovered at Pay By Mail Rates via NOCP ($ millions)[13]	**Subtotal: Adjusted Gross Toll Revenue & Fees ($ millions)**	Less: Credit Card Fees ($ millions)[14]	[22a - 22d roll up to column 22] *Transponder Purchase and Inventory Costs ($ millions)*	*State Operations Costs ($ millions)*	*Customer Service Center (CSC) Vendor O&M Costs ($ millions)*	*Roadway Toll Systems (RTS) O&M Costs ($ millions)*	Less: Toll Collection O&M Costs ($ millions)[15]	Less: Routine Facility O&M Costs ($ millions)[16]	**Total Net Toll Revenue Before R&R ($ millions)**	Periodic Toll Equipment and CSC Repair & Replacement (R&R) Costs ($ millions)[17]	Periodic Facility Repair & Replacement (R&R) Costs ($ millions)[18]	Civil Penalty Revenue Collected from Unpaid Toll Bills ($ millions)[19]	Civil Penalty Adjudication and Collection Costs ($ millions)[20]
2019	1.41	0.29	0.06	**7.35**	(0.12)	*(1.41)*	*(1.16)*	*(0.87)*	*(0.27)*	(3.71)	(1.53)	**1.99**	-	-	0.50	(0.65)
2020	0.35	0.97	0.24	**19.85**	(0.39)	*(0.35)*	*(3.18)*	*(2.88)*	*(0.81)*	(7.23)	(4.70)	**7.53**	-	(0.01)	2.12	(1.60)
2021	0.42	1.26	0.41	**24.73**	(0.48)	*(0.42)*	*(3.78)*	*(3.23)*	*(0.74)*	(8.18)	(4.81)	**11.26**	-	-	3.64	(1.82)
2022	0.44	1.31	0.46	**25.76**	(0.50)	*(0.44)*	*(3.94)*	*(3.38)*	*(0.78)*	(8.54)	(4.93)	**11.78**	-	(0.01)	4.07	(1.90)
2023	0.46	1.29	0.46	**25.91**	(0.51)	*(0.46)*	*(3.97)*	*(3.43)*	*(0.79)*	(8.66)	(5.04)	**11.70**	-	-	4.09	(1.91)
2024	0.47	1.28	0.45	**26.04**	(0.51)	*(0.47)*	*(4.03)*	*(3.55)*	*(0.83)*	(8.88)	(5.16)	**11.48**	(0.42)	(0.01)	4.03	(1.97)
2025	0.49	1.26	0.45	**26.17**	(0.51)	*(0.49)*	*(4.11)*	*(3.63)*	*(0.87)*	(9.09)	(5.27)	**11.29**	(0.91)	-	3.99	(2.00)
2026	0.50	1.25	0.44	**26.32**	(0.51)	*(0.50)*	*(4.16)*	*(3.71)*	*(0.88)*	(9.26)	(5.39)	**11.16**	(0.40)	(0.01)	3.94	(2.02)
2027	0.52	1.24	0.44	**26.47**	(0.52)	*(0.52)*	*(4.24)*	*(3.81)*	*(0.92)*	(9.50)	(5.51)	**10.95**	-	-	3.90	(2.05)
2028	0.53	1.22	0.43	**26.64**	(0.52)	*(0.53)*	*(4.31)*	*(3.89)*	*(0.97)*	(9.70)	(5.62)	**10.80**	(5.02)	(5.78)	3.85	(2.08)
2029	0.54	1.21	0.43	**26.79**	(0.52)	*(0.54)*	*(4.39)*	*(4.00)*	*(1.08)*	(10.02)	(5.74)	**10.51**	(7.94)	-	3.81	(2.11)
2030	0.55	1.19	0.42	**26.98**	(0.53)	*(0.55)*	*(4.48)*	*(4.13)*	*(1.12)*	(10.28)	(5.85)	**10.31**	(0.33)	(0.02)	3.76	(2.15)
2031	0.56	1.18	0.42	**27.15**	(0.53)	*(0.56)*	*(4.57)*	*(4.24)*	*(1.03)*	(10.41)	(5.97)	**10.24**	(0.09)	-	3.72	(2.18)
2032	0.57	1.16	0.41	**27.33**	(0.53)	*(0.57)*	*(4.65)*	*(4.44)*	*(1.10)*	(10.76)	(6.08)	**9.95**	(0.21)	(0.02)	3.67	(2.21)
2033	0.58	1.15	0.41	**27.52**	(0.54)	*(0.58)*	*(5.26)*	*(4.86)*	*(1.12)*	(11.83)	(6.20)	**8.96**	(0.56)	(34.81)	3.63	(2.33)
2034	0.59	1.14	0.40	**27.72**	(0.54)	*(0.59)*	*(5.37)*	*(4.99)*	*(1.19)*	(12.15)	(6.31)	**8.71**	(0.67)	(0.02)	3.59	(2.36)
2035	0.60	1.12	0.40	**27.93**	(0.55)	*(0.60)*	*(5.49)*	*(5.23)*	*(1.28)*	(12.60)	(6.43)	**8.35**	(1.06)	-	3.55	(2.39)
2036	0.62	1.11	0.39	**28.14**	(0.55)	*(0.62)*	*(5.61)*	*(5.39)*	*(1.31)*	(12.92)	(6.54)	**8.12**	-	(0.02)	3.51	(2.43)
2037	0.63	1.10	0.39	**28.36**	(0.56)	*(0.63)*	*(5.73)*	*(5.53)*	*(1.39)*	(13.28)	(6.66)	**7.87**	-	-	3.47	(2.47)
2038	0.64	1.09	0.39	**28.60**	(0.56)	*(0.64)*	*(5.86)*	*(5.70)*	*(1.49)*	(13.69)	(6.78)	**7.57**	(6.95)	(17.29)	3.43	(2.51)
2039	0.65	1.08	0.38	**28.83**	(0.57)	*(0.65)*	*(6.00)*	*(5.88)*	*(1.39)*	(13.92)	(6.89)	**7.46**	(11.66)	-	3.40	(2.55)
2040	0.66	1.06	0.38	**29.09**	(0.57)	*(0.66)*	*(6.15)*	*(6.09)*	*(1.43)*	(14.33)	(7.01)	**7.18**	(1.09)	(0.02)	3.36	(2.60)
2041	0.67	1.07	0.38	**29.22**	(0.57)	*(0.67)*	*(6.32)*	*(6.25)*	*(1.32)*	(14.55)	(7.12)	**6.98**	-	-	3.35	(2.67)
2042	0.67	1.07	0.38	**29.37**	(0.58)	*(0.67)*	*(6.49)*	*(6.40)*	*(1.41)*	(14.97)	(7.24)	**6.58**	-	(0.02)	3.36	(2.74)
2043	0.67	1.08	0.38	**29.52**	(0.58)	*(0.67)*	*(6.68)*	*(6.62)*	*(1.44)*	(15.41)	(7.35)	**6.17**	-	(7.05)	3.39	(2.82)
2044	0.68	1.08	0.38	**29.68**	(0.58)	*(0.68)*	*(6.85)*	*(6.78)*	*(1.53)*	(15.83)	(7.47)	**5.79**	(0.85)	(0.02)	3.40	(2.90)
2045	0.68	1.09	0.38	**29.82**	(0.59)	*(0.68)*	*(7.05)*	*(7.01)*	*(1.64)*	(16.38)	(7.58)	**5.27**	(1.36)	-	3.42	(2.98)
2046	0.68	1.09	0.39	**29.97**	(0.59)	*(0.68)*	*(7.25)*	*(7.20)*	*(1.67)*	(16.80)	(7.70)	**4.88**	(0.50)	(0.02)	3.43	(3.07)
2047	0.69	1.10	0.39	**30.13**	(0.59)	*(0.69)*	*(7.45)*	*(7.38)*	*(1.78)*	(17.30)	(7.82)	**4.43**	(0.81)	-	3.45	(3.15)
2048	0.69	1.11	0.39	**30.28**	(0.59)	*(0.69)*	*(7.64)*	*(7.59)*	*(1.91)*	(17.83)	(7.93)	**3.92**	(9.00)	(49.50)	3.47	(3.24)
2049	0.69	1.11	0.39	**30.43**	(0.60)	*(0.69)*	*(7.86)*	*(7.79)*	*(1.78)*	(18.12)	(8.05)	**3.67**	(14.75)	-	3.48	(3.33)
2050	0.70	1.12	0.39	**30.59**	(0.60)	*(0.70)*	*(8.09)*	*(8.02)*	*(1.83)*	(18.64)	(8.16)	**3.19**	(0.55)	(0.02)	3.50	(3.43)
2051	0.70	1.12	0.40	**30.75**	(0.60)	*(0.70)*	*(8.31)*	*(8.23)*	*(1.69)*	(18.92)	(8.28)	**2.95**	-	(88.34)	3.52	(3.53)
2052	0.70	1.13	0.40	**30.89**	(0.61)	*(0.70)*	*(8.54)*	*(8.44)*	*(1.80)*	(19.49)	(8.39)	**2.40**	-	(0.02)	3.54	(3.62)
2053	0.71	1.13	0.40	**31.06**	(0.61)	*(0.71)*	*(8.76)*	*(8.69)*	*(1.84)*	(20.00)	(8.51)	**1.94**	(0.44)	-	3.56	(3.73)
2054	0.71	1.14	0.40	**31.20**	(0.61)	*(0.71)*	*(9.01)*	*(8.91)*	*(1.96)*	(20.59)	(8.62)	**1.37**	(2.06)	(0.02)	3.57	(3.83)
2055	0.71	1.14	0.40	**31.36**	(0.62)	*(0.71)*	*(9.27)*	*(9.17)*	*(2.10)*	(21.26)	(8.74)	**0.75**	(1.74)	-	3.59	(3.94)
2056	0.72	1.15	0.40	**31.53**	(0.62)	*(0.72)*	*(9.53)*	*(9.43)*	*(2.14)*	(21.81)	(8.86)	**0.24**	-	(0.02)	3.61	(4.06)
2057	0.72	1.16	0.41	**31.69**	(0.62)	*(0.72)*	*(9.80)*	*(9.67)*	*(2.19)*	(22.39)	(8.97)	**(0.29)**	-	-	3.63	(4.17)
2058	0.73	1.16	0.41	**31.86**	(0.63)	*(0.73)*	*(10.07)*	*(9.96)*	*(2.25)*	(23.01)	(9.09)	**(0.86)**	(5.81)	(21.75)	3.65	(4.29)
2059	0.73	1.17	0.41	**32.01**	(0.63)	*(0.73)*	*(10.35)*	*(10.21)*	*(2.31)*	(23.59)	(9.20)	**(1.41)**	(12.57)	-	3.66	(4.41)
Totals FY 2019-44	15.50	29.24	10.15	**687.46**	(13.44)	*(15.50)*	*(126.78)*	*(118.92)*	*(28.50)*	(289.70)	(153.60)	**230.72**	(38.17)	(65.10)	90.52	(57.44)
Totals FY 2019-59	26.05	46.16	16.11	**1,151.03**	(22.55)	*(26.05)*	*(255.77)*	*(246.61)*	*(57.37)*	(585.81)	(279.50)	**263.17**	(87.75)	(224.78)	143.60	(112.20)

Footnotes

[1] Reflects the average revenue per passenger car equivalent (PCE) based on time-of-day variable weekday and weekend toll structures.
[2] Annual volume of vehicles subject to tolls in each travel direction; includes autos and trucks.
[3] Converts trucks to a passenger car equivalent (PCE) based on axle number multipliers averaging 1.06 and 2.09 for medium and large trucks, respectively.
[4] Gross toll revenue potential from pre-paid Good To Go! accounts before any adjustments for uncollectible revenue, fees, and credits.
[5] Gross toll revenue potential from customers without established accounts before adjustments for uncollectible revenue, fees, and credits. Forecasts assume an additional toll increment of $2.00 per transaction for Pay By Mail customer transactions.
[6] Includes $0.25 per transaction fee charged for pre-paid Good To Go! Pay By Plate transactions; no annual escalation in fee. No discounts currently assumed.
[7] Inability to read the vehicle license plate due to equipment failure or image obstruction resulting in unbillable revenue.
[8] Inability to identify the vehicle owner's name and address from a readable license plate resulting in unbillable revenue.
[9] Recognized but unpaid toll revenue after 80 days (2 billing cycles) from date of travel; excludes tolls subsequently recovered from a Notice of Civil Penalty (NOCP).
[10] Initially unpaid toll revenue from a toll bill that is later recaptured after 80 days and linked to an account at the Good To Go! toll rate without civil penalty.
[11] Anticipated revenues from transponder sales; forecast values are set equal to transponder inventory purchase costs and credit card fees, as included in column 22/22a.
[12] Late payment rebilling fee of $5 per invoice (no escalation) assessed to Pay By Mail customers who don't pay first invoice; includes fees recovered from a NOCP (6 mo lag).
[13] Initially unpaid toll revenue from a toll bill that is later recovered after 80 days from a NOCP at the Pay By Mail toll rate, with or without the $40 civil penalty.
[14] Credit card fees estimated at 2.20% of applicable gross toll revenues collected via bank card; additional factor included for fees related to account refunds.
[15] Includes (a) transponder purchase/inventory costs; (b) State operations costs for toll bill printing/postage/license plate lookup, accounting, marketing, and vendor oversight; (c) Customer Service Center (CSC) vendor costs for operations and systems software; and (d) Roadway Toll Systems (RTS) O&M costs.
[16] Includes all annual facility O&M costs that are incurred on a routine basis for the roadway and tunnel systems, as revised by the SR 99 Team on 9/21/16.
[17] Includes periodic RTS and CSC vendor re-procurement costs (except FY 2019-20), system testing and acceptance, as well as periodic RTS equipment replacement costs.
[18] Includes facility repair and replacement (R&R) costs for the roadway and tunnel systems and related periodic capital replacement.
[19] $40 civil penalty revenue collected from a portion of the Notice of Civil Penalty statements sent to Pay By Mail customer for toll bills unpaid after 80 days.
[20] Includes adjudication costs for administrative law judges, processing, credit card fees, and collection of tolls / fees from customers of unpaid toll bills that are mailed NOCPs.

General Notes

- Revised Traffic and Gross Revenue Projections prepared by Stantec, dated 3/3/2017.
- Scenario IG-1 assumes one-way, weekday toll rates of $1.25 from 6-9 AM and 3-6 PM; with toll rates set to $1.00 at all other times, including all day on weekends.
- Scenario IG-1 excludes any toll escalation over time.
- Some FY 2019-21 O&M and R&R cost values may differ from the WSDOT proposed decision package budget due in part to inclusion of cost escalation.
- Table values include more precision than displayed.

Figure 7-9: SR 99 Toll Traffic and Revenue Projections, Scenario IG-2: Max Revenue

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Good To Go! Accounts			Pay By Mail / No Account				Toll Revenue Potential			Plus (Less):	Less:	Less:	Plus:	
Fiscal Year	Wtd. Average Toll per PCE Transaction (one-way)[1]	Annual Tunnel Toll Transactions (millions)[2]	PCE Tunnel Volumes (millions)[3]	Wtd. Average Toll per PCE Transaction (one-way)[1]	Annual Tunnel Toll Transactions (millions)[2]	PCE Tunnel Volumes (millions)[3]	**Total Toll Transactions (millions)**	*Good To Go!* Pre-Paid Accounts ($ millions)[4]	Pay By Mail / No Account ($ millions)[5]	**Total Gross Toll Revenue Potential ($ millions)**	Toll Payment Discounts and Fees ($ millions)[6]	Revenue Not Recognized ($ millions)[7, 8]	Unpaid Toll Revenue ($ millions)[9]	Recaptured Toll Revenue at Good To Go! Rates via CPR ($ millions)[10]	**Subtotal: Adjusted Gross Toll Revenue Collected ($ millions)**
2019	$4.55	2.27	2.37	$6.25	0.78	0.81	**3.05**	10.77	5.07	**15.84**	0.11	(0.95)	(1.14)	0.09	**13.95**
2020	$4.67	7.34	7.66	$6.37	2.44	2.55	**9.78**	35.77	16.22	**51.99**	0.36	(2.45)	(3.75)	0.37	**46.53**
2021	$4.79	8.99	9.39	$6.48	2.90	3.03	**11.89**	44.92	19.64	**64.56**	0.44	(2.24)	(4.72)	0.65	**58.68**
2022	$4.91	9.41	9.83	$6.60	2.95	3.08	**12.36**	48.23	20.31	**68.54**	0.46	(2.34)	(4.89)	0.74	**62.51**
2023	$5.03	9.53	9.96	$6.72	2.89	3.02	**12.42**	50.09	20.32	**70.41**	0.46	(2.36)	(4.91)	0.76	**64.37**
2024	$5.16	9.64	10.08	$6.86	2.83	2.96	**12.47**	52.02	20.33	**72.35**	0.46	(2.38)	(4.91)	0.77	**66.29**
2025	$5.29	9.76	10.21	$6.99	2.78	2.91	**12.54**	54.03	20.34	**74.37**	0.46	(2.40)	(4.93)	0.78	**68.28**
2026	$5.43	9.87	10.33	$7.13	2.73	2.86	**12.60**	56.11	20.36	**76.47**	0.47	(2.42)	(4.95)	0.78	**70.35**
2027	$5.56	10.00	10.47	$7.28	2.67	2.80	**12.67**	58.28	20.37	**78.65**	0.47	(2.44)	(4.95)	0.79	**72.51**
2028	$5.71	10.13	10.61	$7.43	2.62	2.74	**12.75**	60.53	20.38	**80.91**	0.47	(2.46)	(4.98)	0.79	**74.74**
2029	$5.86	10.25	10.74	$7.58	2.57	2.69	**12.81**	62.87	20.40	**83.27**	0.47	(2.48)	(4.99)	0.80	**77.07**
2030	$6.00	10.37	10.88	$7.74	2.52	2.64	**12.89**	65.31	20.41	**85.72**	0.48	(2.51)	(5.01)	0.81	**79.50**
2031	$6.16	10.50	11.02	$7.90	2.47	2.59	**12.97**	67.84	20.43	**88.27**	0.48	(2.53)	(5.02)	0.81	**82.01**
2032	$6.31	10.64	11.17	$8.04	2.42	2.54	**13.07**	70.47	20.45	**90.92**	0.48	(2.56)	(5.05)	0.82	**84.62**
2033	$6.48	10.76	11.30	$8.22	2.37	2.49	**13.14**	73.21	20.46	**93.68**	0.49	(2.58)	(5.06)	0.83	**87.35**
2034	$6.64	10.90	11.46	$8.36	2.33	2.45	**13.24**	76.06	20.48	**96.53**	0.49	(2.61)	(5.09)	0.84	**90.16**
2035	$6.81	11.04	11.60	$8.52	2.29	2.41	**13.33**	79.02	20.50	**99.52**	0.49	(2.64)	(5.11)	0.85	**93.11**
2036	$6.98	11.18	11.75	$8.71	2.24	2.36	**13.42**	82.09	20.52	**102.61**	0.50	(2.67)	(5.12)	0.85	**96.17**
2037	$7.16	11.33	11.92	$8.91	2.19	2.31	**13.52**	85.31	20.54	**105.85**	0.50	(2.70)	(5.14)	0.86	**99.37**
2038	$7.35	11.46	12.07	$9.05	2.16	2.27	**13.62**	88.63	20.56	**109.19**	0.51	(2.73)	(5.18)	0.87	**102.64**
2039	$7.53	11.61	12.22	$9.23	2.12	2.23	**13.72**	92.10	20.58	**112.67**	0.51	(2.77)	(5.19)	0.88	**106.10**
2040	$7.72	11.76	12.40	$9.42	2.08	2.19	**13.84**	95.70	20.61	**116.31**	0.51	(2.80)	(5.22)	0.89	**109.69**
2041	$7.92	11.82	12.45	$9.60	2.09	2.20	**13.90**	98.62	21.12	**119.74**	0.52	(2.88)	(5.36)	0.90	**112.93**
2042	$8.12	11.87	12.51	$9.83	2.09	2.20	**13.96**	101.62	21.64	**123.26**	0.52	(2.95)	(5.48)	0.93	**116.28**
2043	$8.32	11.94	12.58	$9.99	2.11	2.22	**14.04**	104.70	22.18	**126.89**	0.52	(3.03)	(5.64)	0.96	**119.69**
2044	$8.54	11.99	12.64	$10.22	2.11	2.22	**14.10**	107.89	22.72	**130.61**	0.52	(3.11)	(5.76)	0.99	**123.25**
2045	$8.75	12.05	12.70	$10.37	2.13	2.25	**14.19**	111.18	23.29	**134.47**	0.53	(3.20)	(5.93)	1.02	**126.88**
2046	$8.98	12.11	12.76	$10.62	2.13	2.25	**14.24**	114.56	23.87	**138.43**	0.53	(3.28)	(6.05)	1.05	**130.67**
2047	$9.20	12.17	12.83	$10.78	2.15	2.27	**14.33**	118.05	24.45	**142.50**	0.53	(3.37)	(6.23)	1.08	**134.51**
2048	$9.43	12.24	12.90	$11.05	2.15	2.27	**14.39**	121.65	25.06	**146.71**	0.54	(3.46)	(6.36)	1.11	**138.53**
2049	$9.67	12.31	12.97	$11.22	2.17	2.29	**14.48**	125.35	25.68	**151.04**	0.54	(3.55)	(6.55)	1.14	**142.61**
2050	$9.92	12.36	13.03	$11.48	2.18	2.29	**14.54**	129.16	26.31	**155.47**	0.54	(3.64)	(6.69)	1.18	**146.85**
2051	$10.17	12.41	13.08	$11.66	2.20	2.31	**14.61**	133.09	26.98	**160.06**	0.54	(3.74)	(6.89)	1.21	**151.19**
2052	$10.43	12.48	13.15	$11.93	2.20	2.32	**14.68**	137.15	27.63	**164.78**	0.55	(3.84)	(7.04)	1.25	**155.70**
2053	$10.70	12.54	13.21	$12.12	2.22	2.34	**14.75**	141.31	28.32	**169.64**	0.55	(3.94)	(7.24)	1.29	**160.29**
2054	$10.97	12.60	13.28	$12.41	2.22	2.34	**14.82**	145.63	29.02	**174.65**	0.55	(4.05)	(7.40)	1.33	**165.08**
2055	$11.24	12.67	13.35	$12.61	2.24	2.36	**14.90**	150.06	29.74	**179.79**	0.55	(4.16)	(7.61)	1.37	**169.94**
2056	$11.52	12.74	13.42	$12.85	2.25	2.37	**14.99**	154.62	30.47	**185.09**	0.56	(4.27)	(7.80)	1.41	**174.99**
2057	$11.81	12.81	13.49	$13.11	2.26	2.38	**15.07**	159.33	31.22	**190.55**	0.56	(4.38)	(7.99)	1.45	**180.19**
2058	$12.11	12.86	13.55	$13.37	2.27	2.39	**15.13**	164.17	32.00	**196.17**	0.56	(4.50)	(8.19)	1.50	**185.54**
2059	$12.42	12.93	13.62	$13.63	2.28	2.41	**15.21**	169.17	32.80	**201.96**	0.57	(4.62)	(8.40)	1.54	**191.05**
Totals FY 2019-44		266.35	279.61		61.73	64.76	**328.07**	1,822.16	516.96	**2,339.12**	12.15	(65.98)	(127.54)	20.39	**2,178.14**
Totals FY 2019-59		453.61	476.97		94.77	99.59	**548.38**	3,896.61	933.81	**4,830.42**	20.35	(123.98)	(233.92)	39.31	**4,532.18**

1	17	18	19	20	21	22a	22b	22c	22d	22	23	24	25	26	27	28
	Plus:	Plus:	Plus:		Less:	[22a - 22d roll up to column 22]				Less:	Less:					
Fiscal Year	Transponder Sales Revenue ($ millions)[11]	Pay By Mail Rebilling Fees (2nd Invoice & Later Recovery) ($ millions)[12]	Toll Revenue Recovered at Pay By Mail Rates via NOCP ($ millions)[13]	**Subtotal: Adjusted Gross Toll Revenue & Fees ($ millions)**	Credit Card Fees ($ millions)[14]	*Transponder Purchase and Inventory Costs ($ millions)*	*State Operations Costs ($ millions)*	*Customer Service Center (CSC) Vendor O&M Costs ($ millions)*	*Roadway Toll Systems (RTS) O&M Costs ($ millions)*	Toll Collection O&M Costs ($ millions)[15]	Routine Facility O&M Costs ($ millions)[16]	**Total Net Toll Revenue Before R&R ($ millions)**	Periodic Toll Equipment and CSC Repair & Replacement (R&R) Costs ($ millions)[17]	Periodic Facility Repair & Replacement (R&R) Costs ($ millions)[18]	Civil Penalty Revenue Collected from Unpaid Toll Bills ($ millions)[19]	Civil Penalty Adjudication and Collection Costs ($ millions)[20]
2019	1.38	0.21	0.09	**15.62**	(0.29)	(1.38)	(0.92)	(0.87)	(0.27)	(3.43)	(1.53)	**10.37**	-	-	0.36	(0.48)
2020	0.27	0.70	0.38	**47.88**	(0.97)	(0.27)	(2.51)	(2.22)	(0.81)	(5.82)	(4.70)	**36.40**	-	(0.01)	1.54	(1.21)
2021	0.33	0.91	0.65	**60.57**	(1.21)	(0.33)	(2.96)	(2.50)	(0.74)	(6.54)	(4.81)	**48.01**	-	-	2.64	(1.39)
2022	0.34	0.94	0.74	**64.54**	(1.29)	(0.34)	(3.08)	(2.49)	(0.78)	(6.70)	(4.93)	**51.62**	-	(0.01)	2.94	(1.45)
2023	0.35	0.93	0.75	**66.41**	(1.33)	(0.35)	(3.10)	(2.53)	(0.79)	(6.77)	(5.04)	**53.26**	-	-	2.95	(1.45)
2024	0.36	0.91	0.76	**68.33**	(1.37)	(0.36)	(3.13)	(2.59)	(0.83)	(6.91)	(5.16)	**54.89**	(0.42)	(0.01)	2.90	(1.46)
2025	0.37	0.90	0.76	**70.31**	(1.41)	(0.37)	(3.17)	(2.65)	(0.87)	(7.07)	(5.27)	**56.56**	(0.86)	-	2.85	(1.48)
2026	0.38	0.89	0.76	**72.38**	(1.45)	(0.38)	(3.21)	(2.69)	(0.88)	(7.16)	(5.39)	**58.37**	(0.30)	(0.01)	2.80	(1.49)
2027	0.39	0.87	0.76	**74.54**	(1.50)	(0.39)	(3.25)	(2.78)	(0.92)	(7.34)	(5.51)	**60.20**	-	-	2.75	(1.51)
2028	0.40	0.85	0.77	**76.76**	(1.54)	(0.40)	(3.29)	(2.83)	(0.97)	(7.50)	(5.62)	**62.10**	(4.46)	(5.78)	2.70	(1.50)
2029	0.41	0.84	0.77	**79.09**	(1.59)	(0.41)	(3.34)	(2.89)	(1.08)	(7.72)	(5.74)	**64.04**	(6.72)	-	2.66	(1.51)
2030	0.41	0.82	0.77	**81.50**	(1.64)	(0.41)	(3.40)	(2.97)	(1.12)	(7.90)	(5.85)	**66.11**	(0.33)	(0.02)	2.61	(1.53)
2031	0.42	0.81	0.77	**84.01**	(1.69)	(0.42)	(3.46)	(3.02)	(1.03)	(7.93)	(5.97)	**68.42**	(0.09)	-	2.57	(1.55)
2032	0.42	0.80	0.78	**86.61**	(1.74)	(0.42)	(3.51)	(3.11)	(1.10)	(8.15)	(6.08)	**70.64**	(0.16)	(0.02)	2.53	(1.56)
2033	0.43	0.79	0.78	**89.34**	(1.80)	(0.43)	(3.98)	(3.44)	(1.12)	(8.98)	(6.20)	**72.37**	(0.41)	(34.81)	2.49	(1.64)
2034	0.43	0.77	0.78	**92.15**	(1.86)	(0.43)	(4.05)	(3.54)	(1.19)	(9.22)	(6.31)	**74.76**	(0.67)	(0.02)	2.45	(1.66)
2035	0.44	0.76	0.79	**95.10**	(1.92)	(0.44)	(4.13)	(3.62)	(1.28)	(9.47)	(6.43)	**77.28**	(1.06)	-	2.41	(1.67)
2036	0.45	0.75	0.79	**98.16**	(1.98)	(0.45)	(4.20)	(3.70)	(1.31)	(9.65)	(6.54)	**79.98**	-	(0.02)	2.37	(1.69)
2037	0.45	0.73	0.79	**101.35**	(2.05)	(0.45)	(4.28)	(3.80)	(1.39)	(9.92)	(6.66)	**82.72**	-	-	2.33	(1.71)
2038	0.46	0.73	0.80	**104.62**	(2.11)	(0.46)	(4.37)	(3.94)	(1.49)	(10.25)	(6.78)	**85.48**	(6.04)	(17.29)	2.29	(1.73)
2039	0.47	0.71	0.80	**108.08**	(2.18)	(0.47)	(4.46)	(4.06)	(1.39)	(10.37)	(6.89)	**88.63**	(9.59)	-	2.26	(1.75)
2040	0.47	0.70	0.80	**111.67**	(2.26)	(0.47)	(4.55)	(4.19)	(1.43)	(10.65)	(7.01)	**91.75**	(0.91)	(0.02)	2.23	(1.77)
2041	0.47	0.71	0.82	**114.92**	(2.32)	(0.47)	(4.68)	(4.31)	(1.32)	(10.78)	(7.12)	**94.70**	-	-	2.22	(1.82)
2042	0.48	0.71	0.84	**118.30**	(2.39)	(0.48)	(4.80)	(4.41)	(1.41)	(11.10)	(7.24)	**97.57**	-	(0.02)	2.22	(1.87)
2043	0.48	0.71	0.86	**121.74**	(2.46)	(0.48)	(4.94)	(4.55)	(1.44)	(11.41)	(7.35)	**100.52**	-	(7.05)	2.23	(1.93)
2044	0.48	0.71	0.88	**125.32**	(2.54)	(0.48)	(5.06)	(4.65)	(1.53)	(11.73)	(7.47)	**103.59**	(0.85)	(0.02)	2.24	(1.98)
2045	0.48	0.72	0.90	**128.99**	(2.61)	(0.48)	(5.22)	(4.80)	(1.64)	(12.15)	(7.58)	**106.65**	(1.36)	-	2.26	(2.04)
2046	0.49	0.72	0.92	**132.80**	(2.69)	(0.49)	(5.36)	(4.93)	(1.67)	(12.44)	(7.70)	**109.97**	(0.40)	(0.02)	2.27	(2.09)
2047	0.49	0.73	0.95	**136.67**	(2.77)	(0.49)	(5.51)	(5.06)	(1.78)	(12.84)	(7.82)	**113.25**	(0.59)	-	2.28	(2.15)
2048	0.49	0.73	0.97	**140.72**	(2.85)	(0.49)	(5.65)	(5.20)	(1.91)	(13.25)	(7.93)	**116.69**	(7.79)	(49.50)	2.29	(2.21)
2049	0.49	0.73	0.99	**144.83**	(2.93)	(0.49)	(5.82)	(5.35)	(1.78)	(13.44)	(8.05)	**120.42**	(12.14)	-	2.30	(2.28)
2050	0.50	0.74	1.02	**149.10**	(3.02)	(0.50)	(5.98)	(5.50)	(1.83)	(13.80)	(8.16)	**124.12**	(0.55)	(0.02)	2.31	(2.34)
2051	0.50	0.74	1.04	**153.47**	(3.11)	(0.50)	(6.15)	(5.64)	(1.69)	(13.97)	(8.28)	**128.11**	-	(88.34)	2.33	(2.41)
2052	0.50	0.74	1.07	**158.01**	(3.20)	(0.50)	(6.31)	(5.78)	(1.80)	(14.40)	(8.39)	**132.03**	-	(0.02)	2.34	(2.48)
2053	0.50	0.75	1.09	**162.63**	(3.30)	(0.50)	(6.49)	(5.93)	(1.84)	(14.77)	(8.51)	**136.06**	(0.32)	-	2.35	(2.55)
2054	0.51	0.75	1.12	**167.46**	(3.39)	(0.51)	(6.66)	(6.20)	(1.96)	(15.32)	(8.62)	**140.12**	(1.80)	(0.02)	2.36	(2.62)
2055	0.51	0.76	1.15	**172.36**	(3.49)	(0.51)	(6.86)	(6.40)	(2.10)	(15.87)	(8.74)	**144.26**	(1.74)	-	2.37	(2.69)
2056	0.51	0.76	1.18	**177.44**	(3.60)	(0.51)	(7.05)	(6.56)	(2.14)	(16.26)	(8.86)	**148.73**	-	(0.02)	2.39	(2.78)
2057	0.51	0.77	1.21	**182.68**	(3.70)	(0.51)	(7.25)	(6.73)	(2.19)	(16.69)	(8.97)	**153.32**	-	-	2.40	(2.85)
2058	0.52	0.77	1.24	**188.06**	(3.81)	(0.52)	(7.45)	(6.90)	(2.25)	(17.12)	(9.09)	**158.04**	(4.24)	(21.75)	2.41	(2.94)
2059	0.52	0.77	1.27	**193.61**	(3.93)	(0.52)	(7.66)	(7.08)	(2.31)	(17.57)	(9.20)	**162.92**	(9.17)	-	2.42	(3.02)
Totals FY 2019-44	11.75	20.19	19.22	**2,229.30**	(44.89)	(11.75)	(95.85)	(84.35)	(28.50)	(220.46)	(153.60)	**1,810.35**	(32.90)	(65.10)	62.54	(40.80)
Totals FY 2019-59	19.26	31.37	35.34	**4,618.15**	(93.29)	(19.26)	(191.27)	(172.42)	(57.37)	(440.33)	(279.50)	**3,805.03**	(72.99)	(224.78)	97.62	(78.25)

Footnotes

[1] Reflects the average revenue per passenger car equivalent (PCE) based on time-of-day variable weekday and weekend toll structures.
[2] Annual volume of vehicles subject to tolls in each travel direction; includes autos and trucks.
[3] Converts trucks to a passenger car equivalent (PCE) based on axle number multipliers averaging 1.06 and 2.09 for medium and large trucks, respectively.
[4] Gross toll revenue potential from pre-paid Good To Go! accounts before any adjustments for uncollectible revenue, fees, and credits.
[5] Gross toll revenue potential from customers without established accounts before adjustments for uncollectible revenue, fees, and credits. Forecasts assume an additional toll increment of $2.00 per transaction for Pay By Mail customer transactions.
[6] Includes $0.25 per transaction fee charged for pre-paid Good To Go! Pay By Plate transactions; no annual escalation in fee. No discounts currently assumed.
[7] Inability to read the vehicle license plate due to equipment failure or image obstruction resulting in unbillable revenue.
[8] Inability to identify the vehicle owner's name and address from a readable license plate resulting in unbillable revenue.
[9] Recognized but unpaid toll revenue after 80 days (2 billing cycles) from date of travel; excludes tolls subsequently recovered from a Notice of Civil Penalty (NOCP).
[10] Initially unpaid toll revenue from a toll bill that is later recaptured after 80 days and linked to an account at the Good To Go! toll rate without civil penalty.
[11] Anticipated revenues from transponder sales; forecast values are set equal to transponder inventory purchase costs and credit card fees, as included in column 22/22a.
[12] Late payment rebilling fee of $5 per invoice (no escalation) assessed to Pay By Mail customers who don't pay first invoice; includes fees recovered from a NOCP (6 mo lag).
[13] Initially unpaid toll revenue from a toll bill that is later recovered after 80 days from a NOCP at the Pay By Mail toll rate, with or without the $40 civil penalty.
[14] Credit card fees estimated at 2.20% of applicable gross toll revenues collected via bank card; additional factor included for fees related to account refunds.
[15] Includes (a) transponder purchase/inventory costs; (b) State operations costs for toll bill printing/postage/license plate lookup, accounting, marketing, and vendor oversight; (c) Customer Service Center (CSC) vendor costs for operations and systems software; and (d) Roadway Toll Systems (RTS) O&M costs.
[16] Includes all annual facility O&M costs that are incurred on a routine basis for the roadway and tunnel systems, as revised by the SR 99 Team on 9/21/16.
[17] Includes periodic RTS and CSC vendor re-procurement costs (except FY 2019-20), system testing and acceptance, as well as periodic RTS equipment replacement costs.
[18] Includes facility repair and replacement (R&R) costs for the roadway and tunnel systems and related periodic capital replacement.
[19] $40 civil penalty revenue collected from a portion of the Notice of Civil Penalty statements sent to Pay By Mail customer for toll bills unpaid after 80 days.
[20] Includes adjudication costs for administrative law judges, processing, credit card fees, and collection of tolls / fees from customers of unpaid toll bills that are mailed NOCPs.

General Notes

- Revised Traffic and Gross Revenue Projections prepared by Stantec, dated 1/3/2017.
- Scenario IG-2 assumes one-way, weekday toll rates rates of $6.80 from 3-6 PM; $5.80 from 6-9 AM; $4.95 from 5-6 AM, 9 AM-3 PM, and 6-11 PM; and $1.10 from 11 PM-5 AM. Weekend tolls are $1.10 at all times.
- Scenario IG-2 includes 2.5% annual toll escalation.
- Some FY 2019-21 O&M and R&R cost values may differ from the WSDOT proposed decision package budget due in part to inclusion of cost escalation.
- Table values include more precision than displayed.

Figure 7-10: SR 99 Toll Traffic and Revenue Projections, Option A: WSTC Adopted Toll Rates

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Good To Go! Accounts			Pay By Mail / No Account				Toll Revenue Potential							
Fiscal Year	Wtd. Average Toll per PCE Transaction (one-way)[1]	Annual Tunnel Toll Transactions (millions)[2]	PCE Tunnel Volumes (millions)[3]	Wtd. Average Toll per PCE Transaction (one-way)[1]	Annual Tunnel Toll Transactions (millions)[2]	PCE Tunnel Volumes (millions)[3]	Total Toll Transactions (millions)	Good To Go! Pre-Paid Accounts ($ millions)[4]	Pay By Mail / No Account ($ millions)[5]	Total Gross Toll Revenue Potential ($ millions)	Plus (Less): Toll Payment Discounts and Fees ($ millions)[6]	Less: Revenue Not Recognized ($ millions)[7]	Less: Unpaid Toll Revenue ($ millions)[8]	Plus: Recaptured Toll Revenue at Good To Go! Rates via CPR ($ millions)[9]	Subtotal: Adjusted Gross Toll Revenue Collected ($ millions)
2019		-	-		-	-	-	-	-	-	-	-	-	-	-
2020	$1.46	9.45	9.84	$3.38	3.15	3.28	**12.60**	14.39	11.07	**25.46**	0.46	(1.55)	(2.53)	-	**21.84**
2021	$1.46	11.21	11.67	$3.38	3.62	3.76	**14.83**	17.07	12.72	**29.80**	0.55	(1.33)	(3.02)	0.26	**26.25**
2022	$1.46	12.43	12.94	$3.37	3.89	4.05	**16.32**	18.94	13.66	**32.60**	0.60	(1.44)	(3.25)	0.29	**28.80**
2023	$1.51	12.74	13.26	$3.43	3.86	4.01	**16.59**	19.99	13.76	**33.75**	0.61	(1.46)	(3.25)	0.31	**29.97**
2024	$1.51	12.98	13.52	$3.42	3.82	3.97	**16.80**	20.39	13.59	**33.98**	0.62	(1.45)	(3.24)	0.32	**30.22**
2025	$1.51	13.24	13.79	$3.42	3.76	3.92	**17.01**	20.79	13.42	**34.21**	0.63	(1.43)	(3.20)	0.31	**30.52**
2026	$1.55	13.44	13.99	$3.47	3.70	3.85	**17.14**	21.75	13.38	**35.14**	0.63	(1.44)	(3.18)	0.31	**31.47**
2027	$1.55	13.70	14.27	$3.47	3.66	3.81	**17.36**	22.18	13.22	**35.41**	0.64	(1.43)	(3.17)	0.31	**31.77**
2028	$1.56	13.97	14.55	$3.48	3.61	3.76	**17.58**	22.63	13.07	**35.70**	0.65	(1.42)	(3.13)	0.31	**32.11**
2029	$1.60	14.18	14.77	$3.52	3.56	3.70	**17.74**	23.68	13.04	**36.71**	0.66	(1.43)	(3.11)	0.31	**33.14**
2030	$1.60	14.45	15.06	$3.53	3.50	3.65	**17.96**	24.14	12.87	**37.01**	0.67	(1.42)	(3.09)	0.31	**33.48**
2031	$1.60	14.75	15.36	$3.52	3.46	3.61	**18.21**	24.63	12.71	**37.34**	0.67	(1.41)	(3.06)	0.31	**33.85**
2032	$1.65	14.96	15.58	$3.57	3.41	3.55	**18.37**	25.77	12.69	**38.46**	0.68	(1.42)	(3.04)	0.31	**34.99**
2033	$1.65	15.26	15.90	$3.58	3.36	3.50	**18.62**	26.29	12.54	**38.82**	0.69	(1.41)	(3.03)	0.31	**35.39**
2034	$1.65	15.57	16.23	$3.57	3.33	3.47	**18.90**	26.81	12.38	**39.19**	0.70	(1.40)	(3.00)	0.31	**35.80**
2035	$1.70	15.80	16.46	$3.63	3.27	3.41	**19.07**	28.06	12.37	**40.43**	0.71	(1.41)	(2.98)	0.31	**37.06**
2036	$1.71	16.11	16.79	$3.62	3.24	3.37	**19.34**	28.63	12.21	**40.84**	0.72	(1.40)	(2.98)	0.31	**37.50**
2037	$1.70	16.44	17.13	$3.62	3.20	3.33	**19.63**	29.20	12.06	**41.26**	0.73	(1.39)	(2.94)	0.31	**37.97**
2038	$1.76	16.68	17.39	$3.67	3.14	3.28	**19.82**	30.58	12.04	**42.62**	0.74	(1.40)	(2.92)	0.31	**39.34**
2039	$1.76	17.02	17.75	$3.68	3.10	3.24	**20.12**	31.20	11.90	**43.10**	0.75	(1.40)	(2.91)	0.31	**39.85**
2040	$1.76	17.35	18.09	$3.68	3.06	3.19	**20.41**	31.81	11.74	**43.55**	0.76	(1.39)	(2.88)	0.31	**40.34**
2041	$1.81	17.41	18.16	$3.73	3.07	3.20	**20.49**	32.91	11.95	**44.85**	0.76	(1.42)	(2.91)	0.31	**41.60**
2042	$1.81	17.52	18.27	$3.73	3.09	3.23	**20.62**	33.11	12.03	**45.14**	0.77	(1.43)	(2.95)	0.32	**41.84**
2043	$1.81	17.63	18.38	$3.72	3.11	3.25	**20.74**	33.31	12.09	**45.41**	0.77	(1.44)	(2.97)	0.32	**42.09**
2044	$1.87	17.68	18.44	$3.79	3.12	3.25	**20.80**	34.46	12.30	**46.76**	0.77	(1.47)	(3.00)	0.33	**43.40**
2045	$1.87	17.79	18.55	$3.78	3.14	3.27	**20.93**	34.67	12.38	**47.05**	0.78	(1.48)	(3.04)	0.33	**43.64**
2046	$1.87	17.90	18.66	$3.78	3.16	3.29	**21.05**	34.88	12.46	**47.34**	0.78	(1.48)	(3.06)	0.33	**43.91**
2047	$1.93	17.96	18.73	$3.84	3.17	3.30	**21.13**	36.09	12.67	**48.76**	0.79	(1.52)	(3.10)	0.34	**45.27**
2048	$1.93	18.07	18.84	$3.84	3.18	3.32	**21.25**	36.31	12.75	**49.06**	0.79	(1.52)	(3.13)	0.35	**45.54**
2049	$1.93	18.18	18.95	$3.84	3.20	3.34	**21.38**	36.52	12.83	**49.35**	0.79	(1.53)	(3.16)	0.35	**45.80**
2050	$1.99	18.23	19.01	$3.89	3.22	3.36	**21.45**	37.79	13.05	**50.84**	0.80	(1.57)	(3.20)	0.36	**47.23**
2051	$1.99	18.34	19.12	$3.88	3.24	3.38	**21.58**	38.01	13.14	**51.15**	0.80	(1.58)	(3.24)	0.36	**47.50**
2052	$1.99	18.44	19.23	$3.88	3.26	3.40	**21.71**	38.23	13.21	**51.44**	0.81	(1.59)	(3.26)	0.37	**47.77**
2053	$2.05	18.51	19.30	$3.95	3.27	3.40	**21.77**	39.56	13.44	**53.00**	0.81	(1.62)	(3.28)	0.37	**49.28**
2054	$2.05	18.62	19.41	$3.95	3.29	3.43	**21.90**	39.81	13.53	**53.34**	0.81	(1.63)	(3.34)	0.38	**49.56**
2055	$2.05	18.73	19.54	$3.95	3.31	3.45	**22.04**	40.04	13.61	**53.65**	0.82	(1.64)	(3.36)	0.38	**49.85**
2056	$2.11	18.79	19.59	$4.02	3.31	3.45	**22.09**	41.43	13.85	**55.28**	0.82	(1.68)	(3.39)	0.39	**51.43**
2057	$2.11	18.90	19.71	$4.01	3.33	3.47	**22.23**	41.68	13.93	**55.61**	0.83	(1.68)	(3.44)	0.40	**51.70**
2058	$2.11	19.02	19.83	$4.01	3.35	3.50	**22.37**	41.92	14.02	**55.94**	0.83	(1.70)	(3.46)	0.40	**52.01**
2059	$2.18	19.09	19.90	$4.06	3.37	3.52	**22.46**	43.38	14.27	**57.64**	0.83	(1.73)	(3.50)	0.41	**53.65**
Totals FY 2019-46		407.67	424.83		91.37	95.21	**499.04**	712.27	339.65	**1,051.92**	18.50	(38.53)	(81.85)	8.11	**958.14**
Totals FY 2019-59		648.53	676.02		133.87	139.53	**782.40**	1,223.02	513.94	**1,736.96**	29.03	(59.51)	(124.70)	12.95	**1,594.74**

1	17	18	19	27	20	21	22a	22b	22c	22d	22	28	23	24	25	26
							[23a - 23d roll up to column 23]								As Information:	
Fiscal Year	Plus: Transponder Sales Revenue ($ millions)[10]	Plus: Pay By Mail Rebilling Fees (2nd Invoice & Later Recovery) ($ millions)[11]	Plus: Toll Revenue Recovered at Pay By Mail Rates via NOCP ($ millions)[12]	Plus: Civil Penalty Revenue Collected from NOCP Toll Bills ($ millions)[13]	Subtotal: Adjusted Gross Toll Revenue & Fees ($ millions)	Less: Credit Card Fees ($ millions)[14]	*Transponder Purchase and Inventory Costs ($ millions)*	*State Operations Costs ($ millions)*	*Customer Service Center (CSC) Vendor O&M Costs ($ millions)*	*Roadway Toll Systems (RTS) O&M Costs ($ millions)*	Less: Toll Collection O&M Costs ($ millions)[15]	Less: Civil Penalty Adjudication and Collection Costs ($ millions)[16]	Less: Routine Facility O&M Costs ($ millions)[17]	Total Net Toll Revenue Available for Debt Service Before R&R and RSA Deposits ($ millions)	Periodic Toll Equipment / CSC Repair & Replacement (R&R) Costs ($ millions)[18]	Periodic Facility Repair & Replacement (R&R) Costs ($ millions)[19]
2019	-	-	-	-	-	-	-	-	-	*(0.09)*	(0.09)	-	(2.98)	**(3.08)**	(5.81)	-
2020	1.85	0.80	-	-	**24.49**	(0.47)	*(1.85)*	*(3.06)*	*(2.79)*	*(0.87)*	(8.57)	(0.80)	(4.70)	**9.95**	(0.92)	(0.01)
2021	0.42	1.10	0.57	2.57	**30.91**	(0.56)	*(0.42)*	*(3.83)*	*(3.36)*	*(0.80)*	(8.40)	(2.88)	(4.81)	**14.25**	-	-
2022	0.44	1.19	0.62	2.82	**33.87**	(0.61)	*(0.44)*	*(4.07)*	*(3.58)*	*(0.84)*	(8.93)	(3.05)	(4.93)	**16.35**	-	(0.01)
2023	0.46	1.19	0.67	3.01	**35.30**	(0.63)	*(0.46)*	*(4.11)*	*(3.64)*	*(0.85)*	(9.06)	(3.08)	(5.04)	**17.48**	-	-
2024	0.47	1.18	0.67	2.99	**35.52**	(0.64)	*(0.47)*	*(4.16)*	*(3.70)*	*(0.88)*	(9.21)	(3.13)	(5.16)	**17.39**	(0.52)	(0.01)
2025	0.48	1.17	0.66	2.96	**35.78**	(0.64)	*(0.48)*	*(4.23)*	*(3.84)*	*(0.93)*	(9.48)	(3.20)	(5.27)	**17.19**	(1.02)	-
2026	0.50	1.15	0.66	2.92	**36.70**	(0.66)	*(0.50)*	*(4.28)*	*(3.92)*	*(0.94)*	(9.65)	(3.23)	(5.39)	**17.76**	(0.41)	(0.01)
2027	0.52	1.14	0.65	2.89	**36.96**	(0.67)	*(0.52)*	*(4.34)*	*(4.03)*	*(0.98)*	(9.86)	(3.29)	(5.51)	**17.64**	-	-
2028	0.53	1.13	0.65	2.86	**37.27**	(0.68)	*(0.53)*	*(4.40)*	*(4.14)*	*(1.03)*	(10.10)	(3.35)	(5.62)	**17.53**	(5.03)	(5.78)
2029	0.53	1.11	0.64	2.83	**38.26**	(0.70)	*(0.53)*	*(4.46)*	*(4.20)*	*(1.15)*	(10.34)	(3.39)	(5.74)	**18.10**	(8.28)	-
2030	0.55	1.10	0.64	2.79	**38.56**	(0.70)	*(0.55)*	*(4.55)*	*(4.35)*	*(1.17)*	(10.62)	(3.45)	(5.85)	**17.93**	(0.33)	(0.02)
2031	0.56	1.09	0.63	2.76	**38.90**	(0.71)	*(0.56)*	*(4.65)*	*(4.48)*	*(1.10)*	(10.80)	(3.52)	(5.97)	**17.91**	(0.09)	-
2032	0.57	1.08	0.63	2.73	**40.00**	(0.74)	*(0.57)*	*(4.73)*	*(4.59)*	*(1.18)*	(11.06)	(3.57)	(6.08)	**18.55**	-	(0.02)
2033	0.58	1.07	0.63	2.70	**40.36**	(0.74)	*(0.58)*	*(5.33)*	*(5.06)*	*(1.20)*	(12.16)	(3.71)	(6.20)	**17.55**	(0.24)	(34.81)
2034	0.59	1.06	0.62	2.68	**40.75**	(0.75)	*(0.59)*	*(5.45)*	*(5.27)*	*(1.27)*	(12.57)	(3.78)	(6.31)	**17.34**	(1.19)	(0.02)
2035	0.60	1.04	0.62	2.65	**41.98**	(0.78)	*(0.60)*	*(5.55)*	*(5.42)*	*(1.35)*	(12.93)	(3.83)	(6.43)	**18.02**	(1.06)	-
2036	0.61	1.04	0.62	2.62	**42.38**	(0.79)	*(0.61)*	*(5.67)*	*(5.60)*	*(1.38)*	(13.26)	(3.89)	(6.54)	**17.90**	-	(0.02)
2037	0.63	1.03	0.61	2.60	**42.83**	(0.80)	*(0.63)*	*(5.80)*	*(5.84)*	*(1.46)*	(13.72)	(3.98)	(6.66)	**17.68**	-	-
2038	0.64	1.01	0.61	2.57	**44.17**	(0.82)	*(0.64)*	*(5.91)*	*(5.97)*	*(1.56)*	(14.07)	(4.03)	(6.78)	**18.47**	(6.58)	(17.29)
2039	0.65	1.00	0.61	2.54	**44.65**	(0.83)	*(0.65)*	*(6.04)*	*(6.18)*	*(1.56)*	(14.43)	(4.12)	(6.89)	**18.38**	(10.93)	-
2040	0.66	0.99	0.60	2.52	**45.12**	(0.84)	*(0.66)*	*(6.20)*	*(6.39)*	*(1.50)*	(14.75)	(4.19)	(7.01)	**18.33**	(0.43)	(0.02)
2041	0.67	1.00	0.61	2.51	**46.38**	(0.87)	*(0.67)*	*(6.34)*	*(6.56)*	*(1.41)*	(14.98)	(4.31)	(7.12)	**19.09**	(0.30)	-
2042	0.67	1.00	0.61	2.52	**46.65**	(0.88)	*(0.67)*	*(6.51)*	*(6.73)*	*(1.51)*	(15.41)	(4.44)	(7.24)	**18.69**	(0.64)	(0.02)
2043	0.67	1.01	0.62	2.54	**46.93**	(0.88)	*(0.67)*	*(6.67)*	*(6.87)*	*(1.54)*	(15.76)	(4.57)	(7.35)	**18.37**	-	(7.05)
2044	0.68	1.01	0.62	2.55	**48.26**	(0.91)	*(0.68)*	*(6.82)*	*(7.05)*	*(1.62)*	(16.18)	(4.69)	(7.47)	**19.01**	(0.85)	(0.02)
2045	0.68	1.02	0.63	2.56	**48.53**	(0.91)	*(0.68)*	*(7.01)*	*(7.25)*	*(1.73)*	(16.68)	(4.83)	(7.58)	**18.53**	(1.36)	-
2046	0.68	1.02	0.64	2.58	**48.83**	(0.92)	*(0.68)*	*(7.19)*	*(7.43)*	*(1.76)*	(17.07)	(4.98)	(7.70)	**18.15**	(0.13)	(0.02)
2047	0.69	1.03	0.64	2.59	**50.22**	(0.95)	*(0.69)*	*(7.36)*	*(7.63)*	*(1.87)*	(17.55)	(5.12)	(7.82)	**18.79**	-	-
2048	0.69	1.03	0.65	2.60	**50.51**	(0.95)	*(0.69)*	*(7.55)*	*(7.79)*	*(1.99)*	(18.02)	(5.27)	(7.93)	**18.34**	(8.34)	(49.50)
2049	0.69	1.04	0.65	2.61	**50.80**	(0.96)	*(0.69)*	*(7.74)*	*(7.99)*	*(2.00)*	(18.42)	(5.43)	(8.05)	**17.94**	(14.12)	-
2050	0.70	1.05	0.66	2.63	**52.26**	(0.99)	*(0.70)*	*(7.95)*	*(8.17)*	*(1.92)*	(18.73)	(5.58)	(8.16)	**18.81**	(1.31)	(0.02)
2051	0.70	1.05	0.67	2.65	**52.57**	(0.99)	*(0.70)*	*(8.15)*	*(8.37)*	*(1.81)*	(19.04)	(5.76)	(8.28)	**18.50**	-	(88.34)
2052	0.70	1.06	0.67	2.66	**52.87**	(1.00)	*(0.70)*	*(8.36)*	*(8.61)*	*(1.93)*	(19.61)	(5.93)	(8.39)	**17.95**	-	(0.02)
2053	0.71	1.06	0.68	2.67	**54.40**	(1.03)	*(0.71)*	*(8.55)*	*(8.96)*	*(1.97)*	(20.19)	(6.10)	(8.51)	**18.58**	-	-
2054	0.71	1.07	0.69	2.68	**54.71**	(1.03)	*(0.71)*	*(8.77)*	*(9.43)*	*(2.08)*	(20.99)	(6.28)	(8.62)	**17.79**	(1.09)	(0.02)
2055	0.72	1.07	0.69	2.70	**55.04**	(1.04)	*(0.72)*	*(9.02)*	*(9.70)*	*(2.22)*	(21.64)	(6.46)	(8.74)	**17.15**	(1.74)	-
2056	0.72	1.07	0.70	2.71	**56.63**	(1.07)	*(0.72)*	*(9.21)*	*(9.90)*	*(2.26)*	(22.10)	(6.65)	(8.86)	**17.96**	-	(0.02)
2057	0.72	1.08	0.71	2.72	**56.94**	(1.08)	*(0.72)*	*(9.46)*	*(10.17)*	*(2.32)*	(22.67)	(6.85)	(8.97)	**17.37**	(0.42)	-
2058	0.73	1.09	0.72	2.74	**57.28**	(1.08)	*(0.73)*	*(9.74)*	*(10.45)*	*(2.37)*	(23.28)	(7.17)	(9.09)	**16.65**	(5.80)	(21.75)
2059	0.73	1.09	0.72	2.75	**58.95**	(1.12)	*(0.73)*	*(10.02)*	*(10.70)*	*(2.43)*	(23.88)	(7.38)	(9.20)	**17.37**	(10.54)	-
Totals FY 2019-46	16.88	28.72	16.34	70.27	**1,090.35**	(20.12)	*(16.88)*	*(141.36)*	*(138.23)*	*(33.65)*	(330.12)	(99.29)	(170.34)	**470.48**	(46.13)	(65.12)
Totals FY 2019-59	26.09	42.51	25.21	104.99	**1,793.54**	(33.41)	*(26.09)*	*(253.24)*	*(256.12)*	*(60.80)*	(596.25)	(179.25)	(280.96)	**703.67**	(89.48)	(224.78)

Footnotes

[1] Reflects the average revenue per passenger car equivalent (PCE) based on time-of-day variable weekday and weekend toll structures.
[2] Annual volume of vehicles subject to tolls in each travel direction; includes autos and trucks.
[3] Converts trucks to a passenger car equivalent (PCE) based on axle number multipliers averaging 1.06 and 2.09 for medium and large trucks, respectively.
[4] Gross toll revenue potential from pre-paid Good To Go! accounts before any adjustments for uncollectible revenue, fees, and credits.
[5] Gross toll revenue potential from customers without established accounts before adjustments for uncollectible revenue, fees, and credits. Forecasts assume an additional toll increment of $2.00 per transaction for Pay By Mail customer transactions.
[6] Includes $0.25 per transaction fee charged for pre-paid Good To Go! Pay By Plate transactions; no annual escalation in fee. No discounts currently assumed.
[7] Inability to read the vehicle license plate image or inability to identify the vehicle owner's name and address from a readable license plate, both resulting in unbillable revenue.
[8] Recognized but unpaid toll revenue after 80 days (2 billing cycles) from date of travel; excludes tolls subsequently recovered from a Notice of Civil Penalty (NOCP).
[9] Initially unpaid toll revenue from a toll bill that is later recaptured after 80 days and linked to an account at the Good To Go! toll rate without civil penalty.
[10] Anticipated revenues from transponder sales; forecast values are set equal to transponder inventory purchase costs and credit card fees, as included in column 23/23a

11 Late payment rebilling fee of $5 per invoice (no escalation) assessed to Pay By Mail customers who don't pay first invoice; includes fees recovered from a NOCP (6 mo lag).
12 Initially unpaid toll revenue from a toll bill that is later recovered after 80 days from a NOCP at the Pay By Mail toll rate, with or without the $40 civil penalty.
13 $40 civil penalty revenue collected from a portion of the Notice of Civil Penalty statements sent to Pay By Mail customer for toll bills unpaid after 80 days. Column # set to match other tables for Scenarios IG-0, IG-1 and IG-2.
14 Credit card fees estimated at 2.20% of applicable gross toll revenues collected via bank card; additional factor included for fees related to account refunds.
15 Includes (a) transponder purchase/inventory costs; (b) State operations costs for toll bill printing/postage/license plate lookup, accounting, marketing, and vendor
16 oversight; (c) Customer Service Center (CSC) vendor costs for operations and systems software; and (d) Roadway Toll Systems (RTS) O&M costs. Includes adjudication costs for administrative law judges, processing, credit card fees, and collection of tolls / fees from customers of unpaid toll bills that are mailed NOCPs. Column # set to match other tables.
17 Includes all annual facility O&M costs that are incurred on a routine basis for the roadway and tunnel systems, as revised by the SR 99 Team on 9/21/16.
18 Includes periodic RTS and CSC vendor re-procurement costs (except FY 2019-20), system testing and acceptance, as well as periodic RTS equipment replacement costs.
19 Periodic tunnel facility R&R costs are provided as information and are not currently assumed to be funded from tolls.

General Notes Regarding Option A

- Revised Traffic and Gross Revenue Projections prepared by Stantec, dated 5/8/2018.
- Includes revised toll collection O&M and R&R costs based on the Toll Division Decision Package budget request (2/28/2018).
- Option A includes initial one-way, weekday toll rates of of $2.25 from 3-6 PM; $1.50 from 7-9 AM; $1.25 from 6-7 AM, 9 AM-3 PM, and 6-11 PM; and $1.00 from 11 PM-6 AM; Initial weekend tolls are $1.00 at all times.
- Option A assumes 3% toll increases every 3 years, FY 2023-59.
- Toll increases include overnight and weekends.
- Table values include more precision than displayed.

8.0 SENSITIVITY ANALYSES

Sensitivity analyses were performed to understand the effect that key project assumptions would have on the model output.

Four sensitivity scenarios that varied model assumptions were evaluated:

1. Value of Time (VOT) -20% from Base Case
2. Value of Time (VOT) +20% from Base Case
3. SED Growth (Population, Households, and Employment) at 50% Growth from Base Case
4. Gas Prices +50% from Base Case

The results for 2020 average weekday and annual results are shown below in **Table 8-1** and **Table 8-2**. The VOT results are in line with expectations. The VOT +20% scenario resulted in +4.2% in both traffic and revenue for an average weekday. Slightly different results for annual traffic and revenue occur as the higher VOT also causes a change in weekend behavior. Similarly, the VOT -20% scenario has a more pronounced effect, with losses of approximately 5.4% on an average weekday.

The gas price sensitivity (+50%) had a greater than 7% impact on both transactions and revenue. Because gas prices are not a direct input to the model, vehicle operations costs were altered to approximate a 50% increase in gas prices. It is assumed that this scenario approximates gasoline prices between $5.50 and $6.00 per gallon.

A 50% reduction of the growth rate between 2015 and 2020 resulted in approximately a 3% reduction in transactions and revenue for average weekday and a 4.3 to 4.6% reduction in annual transactions and revenue.

Table 8-1: 2020 Average Weekday Sensitivity Results (without ramp up)

FY 2020	Northbound		Southbound		Total	
	Traffic	Revenue	Traffic	Revenue	Traffic	Revenue
IG-0	24,373	$ 57,747	26,987	$ 64,777	51,359	$ 122,524
VOT - 20%	22,911	$ 54,033	25,736	$ 61,923	48,646	$ 115,956
VOT +20%	25,456	$ 60,114	28,056	$ 67,547	53,513	$ 127,661
-50% SED Growth	23,841	$ 55,902	26,007	$ 62,764	49,848	$ 118,666
Gas +50%	22,658	$ 53,453	25,014	$ 60,340	47,673	$ 113,793

FY 2020	Northbound		Southbound		Total	
	Traffic	Revenue	Traffic	Revenue	Traffic	Revenue
IG-0	-	-	-	-	-	-
VOT - 20%	-6.0%	-6.4%	-4.6%	-4.4%	-5.3%	-5.4%
VOT +20%	4.4%	4.1%	4.0%	4.3%	4.2%	4.2%
-50% SED Growth	-2.2%	-3.2%	-3.6%	-3.1%	-2.9%	-3.1%
Gas +50%	-7.0%	-7.4%	-7.3%	-6.8%	-7.2%	-7.1%

Table 8-2: 2020 Annual Sensitivity Results (without ramp up)

FY 2020	Northbound		Southbound		Total	
	Traffic	Revenue	Traffic	Revenue	Traffic	Revenue
IG-0	7,400,000	$ 16,481,000	8,196,000	$ 18,475,000	15,596,000	$ 34,956,000
VOT - 20%	6,862,000	$ 15,299,000	7,718,000	$ 17,525,000	14,580,000	$ 32,824,000
VOT +20%	7,773,000	$ 17,273,000	8,568,000	$ 19,416,000	16,341,000	$ 36,689,000
-50% SED Growth	7,112,000	$ 15,751,000	7,761,000	$ 17,714,000	14,873,000	$ 33,465,000
Gas +50%	6,815,000	$ 15,183,000	7,518,000	$ 17,154,000	14,333,000	$ 32,337,000

FY 2020	Northbound		Southbound		Total	
	Traffic	Revenue	Traffic	Revenue	Traffic	Revenue
IG-0	-	-	-	-	-	-
VOT - 20%	-7.3%	-7.2%	-5.8%	-5.1%	-6.5%	-6.1%
VOT +20%	5.0%	4.8%	4.5%	5.1%	4.8%	5.0%
-50% SED Growth	-3.9%	-4.4%	-5.3%	-4.1%	-4.6%	-4.3%
Gas +50%	-7.9%	-7.9%	-8.3%	-7.2%	-8.1%	-7.5%

The results for 2040 average weekday and annual results are shown below in **Table 8-3** and **Table 8-4.** The biggest differential between these results and the 2020 results is for the SED downside scenario. As continual lower growth leads to larger differences in traffic and revenue over time. Whereas the annual revenue impact in 2020 was -4.3%, this increases to -12.6% by 2040. Lower growth means fewer vehicle trips, less congestion, and therefore less time savings on the SR 99 tunnel. All of this leads to decreasing usage over time.

The VOT (+/- 20%) scenarios are consistent with the 2020 results, though slightly less impactful in 2040 than 2020. This is tied to the no inflation assumption for toll rates. Given that rates are effectively decreasing over time, the SR 99 tunnel is already capturing a higher share of traffic over time so the VOT change is less impactful in increasing that share. The change is minor, however, as in 2020, transactions and revenue saw an approximate 5.0% increase with VOT +20% and in 2040, a 3.6 to 4.0% increase in transactions and revenue. If toll rates were moving with inflation, we would expect the results to be consistent (and maybe even higher) in 2040 than 2020 but in this case, the decreasing toll rates dampen the impacts.

The gas price increase is also less dramatic in 2040, as a -7.5% impact on revenue in 2020 reduces over time to a -4.5% impact by 2040. This can be attributed to changes in the vehicle fleet over time - higher carpooling decreases vehicles costs and fuel efficiencies increase, so a 50% increase in gas prices has a lesser effect on travel over time.

Table 8-3: 2040 Average Weekday Sensitivity Results

FY 2040	Northbound		Southbound		Total	
	Traffic	Revenue	Traffic	Revenue	Traffic	Revenue
IG-0	32,878	$ 71,007	34,332	$ 75,824	67,210	$ 146,831
VOT - 20%	31,387	$ 67,434	33,306	$ 73,614	64,693	$ 141,048
VOT +20%	33,318	$ 72,540	35,813	$ 79,082	69,131	$ 151,621
-50% SED Growth	29,528	$ 63,815	30,116	$ 65,949	59,644	$ 129,764
Gas +50%	31,096	$ 67,495	32,866	$ 72,765	63,963	$ 140,261

FY 2040	Northbound		Southbound		Total	
	Traffic	Revenue	Traffic	Revenue	Traffic	Revenue
IG-0	-	-	-	-	-	-
VOT - 20%	-4.5%	-5.0%	-3.0%	-2.9%	-3.7%	-3.9%
VOT +20%	1.3%	2.2%	4.3%	4.3%	2.9%	3.3%
-50% SED Growth	-10.2%	-10.1%	-12.3%	-13.0%	-11.3%	-11.6%
Gas +50%	-5.4%	-4.9%	-4.3%	-4.0%	-4.8%	-4.5%

Table 8-4: 2040 Annual Sensitivity Results

FY 2040	Northbound		Southbound		Total	
	Traffic	Revenue	Traffic	Revenue	Traffic	Revenue
IG-0	9,972,000	$ 20,263,000	10,422,000	$ 21,639,000	20,394,000	$ 41,902,000
VOT - 20%	9,399,000	$ 19,111,000	9,975,000	$ 20,849,000	19,374,000	$ 39,960,000
VOT +20%	10,180,000	$ 20,871,000	10,938,000	$ 22,727,000	21,118,000	$ 43,598,000
-50% SED Growth	8,823,000	$ 18,011,000	8,998,000	$ 18,611,000	17,821,000	$ 36,622,000
Gas +50%	9,341,000	$ 19,198,000	9,880,000	$ 20,681,000	19,221,000	$ 39,879,000

FY 2040	Northbound		Southbound		Total	
	Traffic	Revenue	Traffic	Revenue	Traffic	Revenue
IG-0	-	-	-	-	-	-
VOT - 20%	-5.7%	-5.7%	-4.3%	-3.7%	-5.0%	-4.6%
VOT +20%	2.1%	3.0%	5.0%	5.0%	3.6%	4.0%
-50% SED Growth	-11.5%	-11.1%	-13.7%	-14.0%	-12.6%	-12.6%
Gas +50%	-6.3%	-5.3%	-5.2%	-4.4%	-5.8%	-4.8%

9.0 RISK ANALYSIS

Stantec conducted a risk analysis of the SR 99 traffic and revenue forecasts for 2020. The risk analysis quantifies the likelihood that the traffic and revenue potential will meet or exceed the forecast.

9.1 RISK ANALYSIS VARIABLES

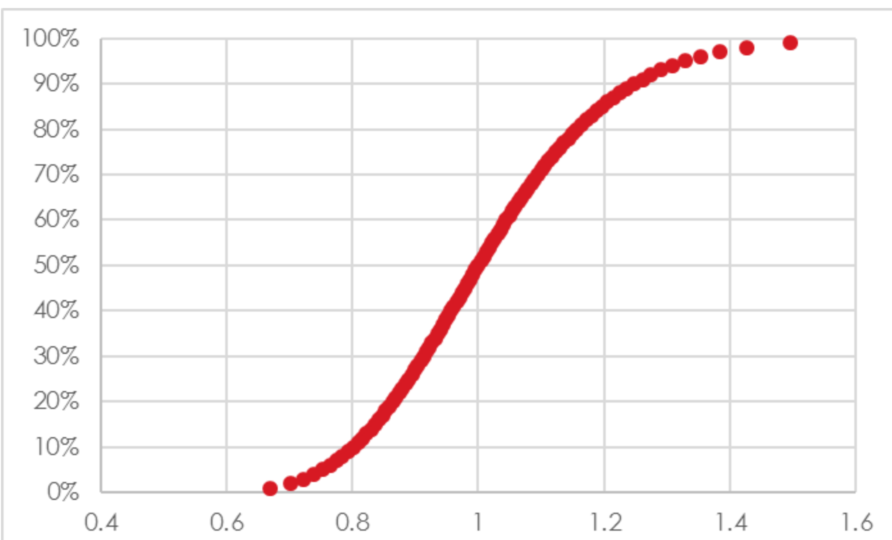
Stantec identified four variables for use in the risk analysis based on their likelihood to impact the traffic and revenue on the SR 99 Tunnel. Stantec determined probability distributions for each variable based available information and previous experience in toll facility projects. The variables are:

1. Automobile Value of Time (VOT)
2. Commercial Vehicle VOT
3. Households in the Study Area
4. Employment in the Study Area

9.1.1 Automobile Value of Time

Automobile VOT was incorporated into the risk analysis because it directly impacts drivers' willingness to pay a toll in exchange for travel time savings. Stantec determined that the automobile VOT value used in the forecast represents the median value for future automobile VOT. Additionally, the future automobile VOT distribution was assumed to be lognormal. **Figure 9-1** shows the cumulative distribution function for automobile VOT.

Figure 9-1: Cumulative Distribution Function, Automobile VOT

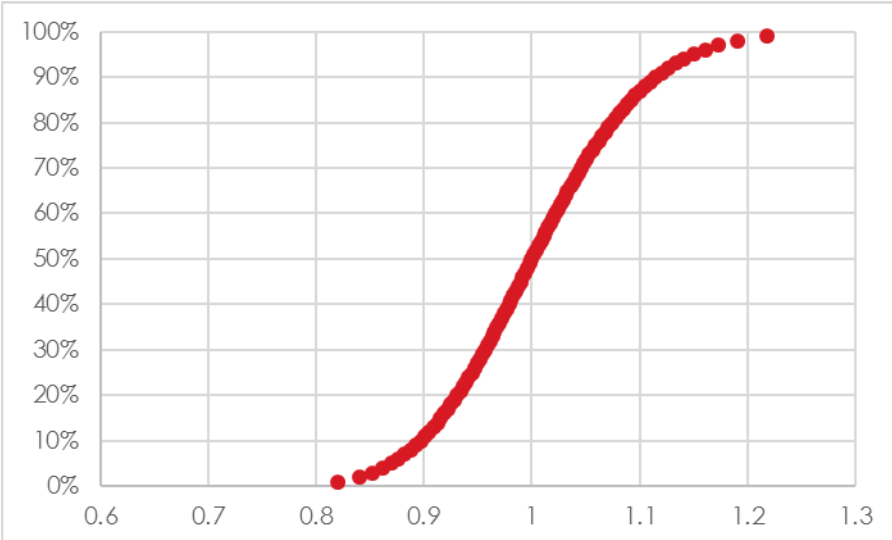


9.1.2 Commercial Vehicle Value of Time

Commercial vehicle value of time was also included in the risk analysis. While commercial vehicles are not a significant portion of projected SR 99 traffic, understanding the potential

impact of higher or lower commercial vehicles VOT is important. A similar distribution and range for commercial vehicle VOT was assumed to align with passenger vehicle VOT. **Figure 9-2** shows the cumulative distribution function utilized for commercial vehicle VOT.

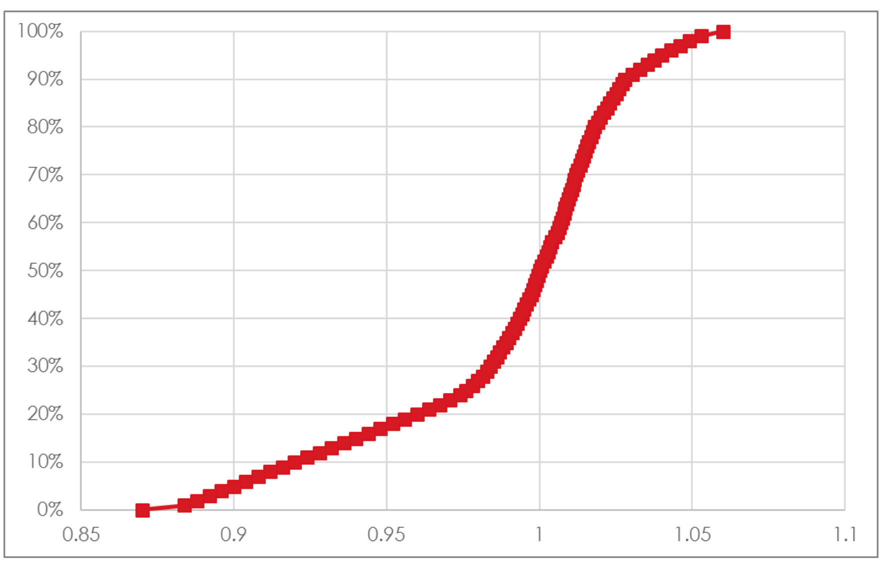
Figure 9-2: Cumulative Distribution Function, Commercial Vehicle VOT



9.1.3 Household Forecast

The number of households in the study area was incorporated into the risk analysis because it is directly proportional to the amount of congestion in the study area, which attracts drivers to the SR 99 Tunnel. Stantec analyzed historic household growth in the study area to determine an appropriate distribution for household growth. **Figure 9-3** shows the cumulative distribution function for the number of households in the study area for 2020.

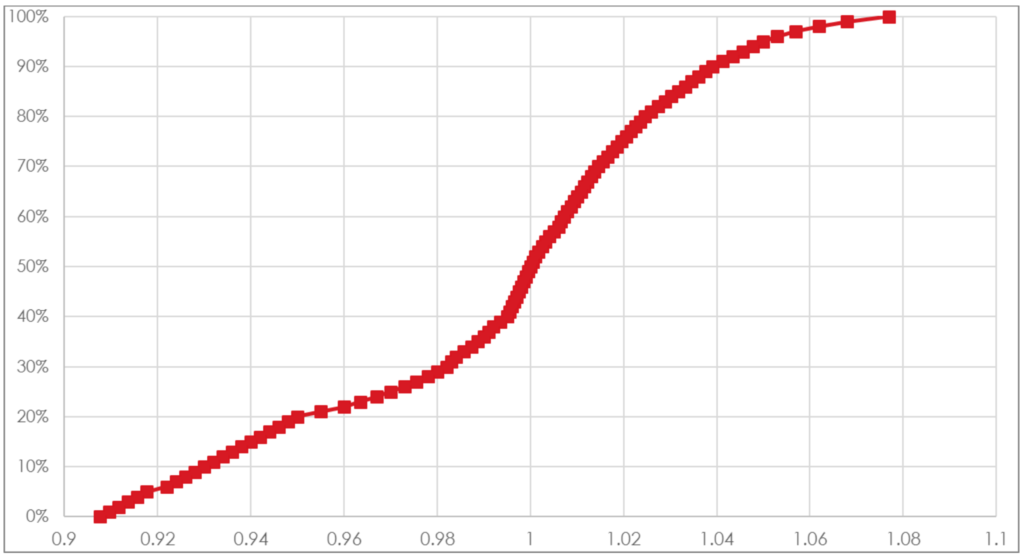
Figure 9-3: Cumulative Distribution Function, 2020 Household Forecast



9.1.4 Employment Forecast

Similar to households, it is important to understand how regional employment can impact the traffic and revenue potential. While households and employment are correlated, scenarios do exist where households may be growing and employment shrinking. Historic regional employment data from bls.gov was summarized and analyzed to help craft the appropriate employment distribution. **Figure 9-4** displays the cumulative distribution function for employment.

Figure 9-4: Cumulative Distribution Function, 2020 Employment Forecast



9.2 LINEAR REGRESSION PARAMETERS

Stantec used a Taguchi orthogonal array to develop a surface model for traffic and revenue based on the parameters. Taguchi orthogonal arrays allow each level of each parameter to be tested equally. This ensures that the impact on traffic and revenue by each parameter is correctly calculated at each level. An orthogonal array with four variables and three levels per variable requires nine scenarios to construct an acceptable surface model. **Table 9-1** shows the orthogonal array used to construct the surface model.

Table 9-1: Orthogonal Array for Risk Analysis

Experiment	Variables			
	HH	Emp	Auto VOT	Comm VOT
1	1	1	1	1
2	1	1.05	1.33	1.15
3	1	0.95	0.8	0.75
4	1.04	1	1.33	0.75
5	1.04	1.05	0.8	1
6	1.04	0.95	1	1.15
7	0.96	1	0.8	1.15
8	0.96	1.05	1	0.75
9	0.96	0.95	1.33	1

Once model runs for the orthogonal array were complete, it was observed that commercial vehicle VOT had a statistically insignificant impact on the overall traffic and revenue results for the project. This variable, therefore, was not part of the subsequent regression analysis.

Each permutation was run through the travel demand model to attain 2020 traffic and revenue results. Stantec used the results to build a linear regression model to estimate traffic and revenue for each year based on the risk analysis variables. The linear regression coefficients for annual traffic and revenue are shown in **Figure 9-5** and **Figure 9-6**, respectively.

Figure 9-5: Linear Regression Coefficients for Traffic

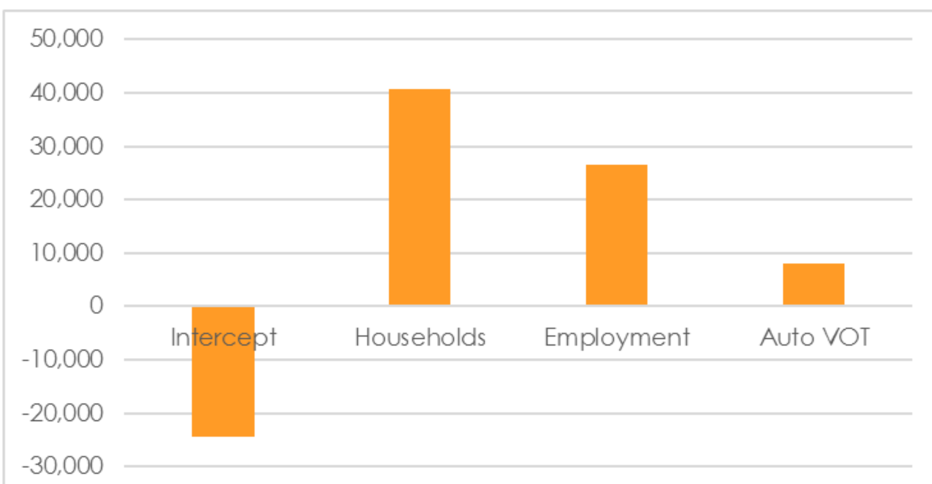
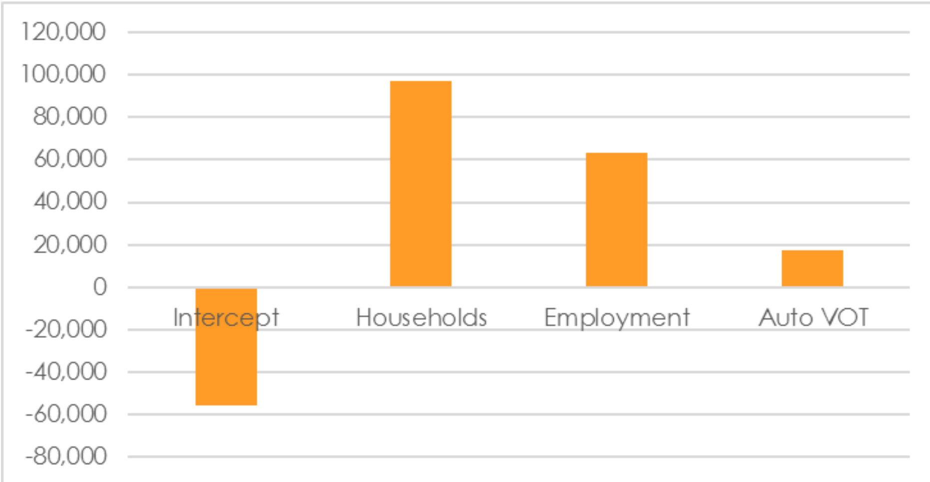


Figure 9-6: Linear Regression Coefficients for Revenue



Traffic coefficients have the same sign as revenue coefficients in all cases. In fact, the coefficients carry similar weightings between traffic and revenue. This suggests that the socioeconomic input variables have a significant impact on the traffic and revenue potential for the SR 99 project. Commercial vehicle VOT has little to no impact on the forecast.

Once the surface model was constructed utilizing the coefficients and inputs detailed above, the results from the surface model were compared to the output from the regional and DTA models. **Figure 9-7** and **Figure 9-8** provide linear regression results for traffic and revenue comparing the surface model to the output from the regional and DTA models.

Figure 9-7: Linear Regression for Average Weekday Traffic

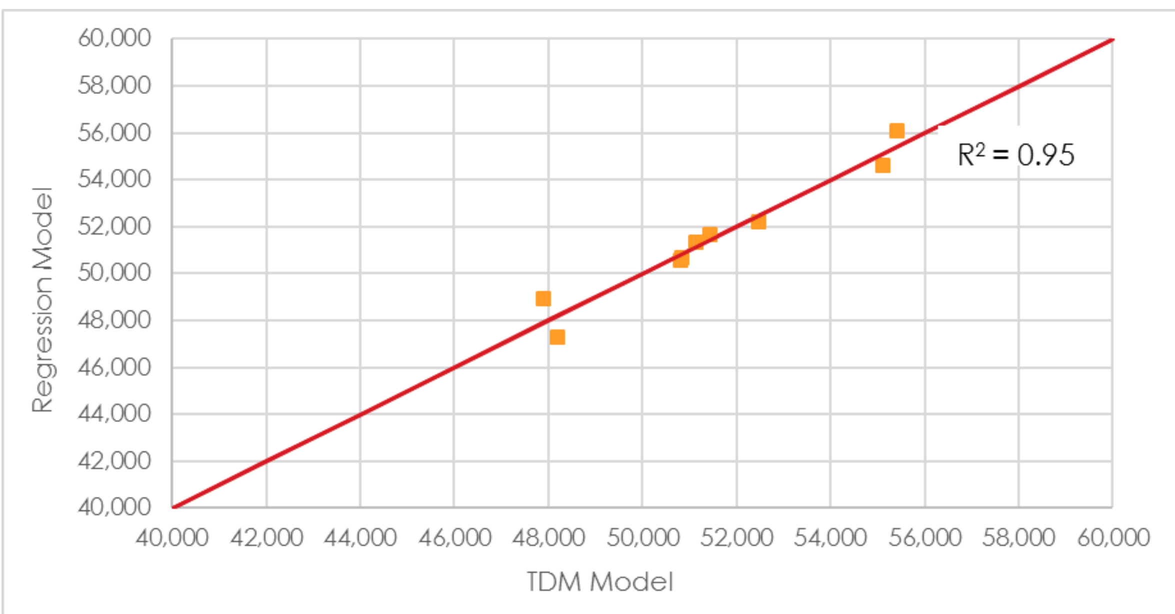
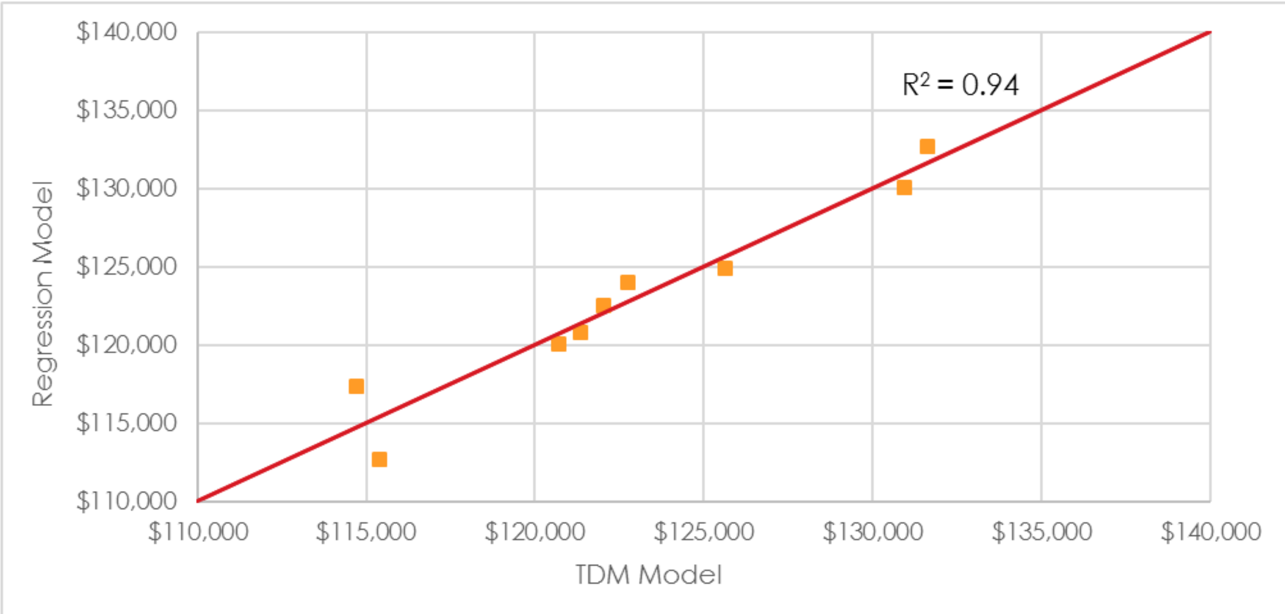


Figure 9-8: Linear Regression for Average Weekday Revenue



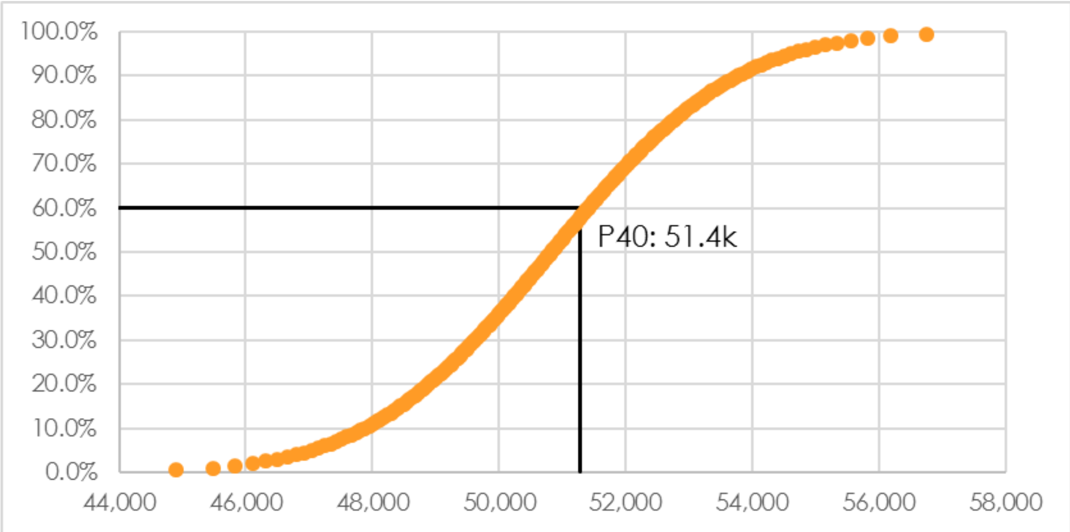
As shown in the figures above, R^2 values of 0.95 for traffic and 0.94 for revenue were achieved with the surface model. This shows a strong correlation between the two models' outputs and therefore proves that the surface model can approximate the output from the regional and DTA models with high levels of accuracy. You can utilize, therefore, the surface model to run thousands of iterations through monte carlo simulation.

9.3 MONTE CARLO SIMULATION

Stantec developed a Monte Carlo simulation that randomly generated values for the risk analysis variables based on their probability distributions. The simulation included one hundred thousand scenarios with unique values for all variables. For each scenario, the linear regression models were used to estimate traffic and revenue for 2020. The one hundred thousand traffic and revenue results for each year form probability distributions.

The median annual traffic from the 2020 distribution is 50,800 transactions in the SR 99 Tunnel, while the forecasted traffic is 51,400 annual transactions. With a standard deviation of 2,300 transactions, there is a 40 percent probability that the forecast will be met or exceeded. **Figure 9-9** shows the 2020 annual traffic cumulative distribution function, along with the forecast's location on the distribution.

Figure 9-9: Annual Transactions, Cumulative Distribution Function



The median value from the 2020 average weekday distribution is $121,300, while the forecasted revenue is $122,500. With a standard deviation of $5,300, there is a 40 percent probability that the forecast will be met or exceeded. **Figure 9-10** shows the 2020 annual revenue cumulative distribution function, along with the forecast's location on the distribution.

Figure 9-10: Annual Revenue, Cumulative Distribution Function

The base forecast is slightly more aggressive than a p50 forecast, though this is not surprising given that two of the input parameters were socioeconomic variables. The distributions for household and employment growth were predicated on an analysis of historical growth rates. Given the recency of the Great Recession, this downturn in growth was factored into the mean and standard deviation for growth expectations. The downside, therefore, in the socioeconomic distributions was greater than the upside. This helps to explain why the base case is shown as a p40 forecast. It should be noted, however, that the difference in the p50 revenue forecast ($121,300) and the base case forecast ($122,500) is less than one percent.